VOL. XXIV, NO. 3 JULY, 1942 Old Series Vol. XL, No. 3

The Journal of
Bone and Joint Surgery

"EOSINOPHILIC OR SOLITARY GRANULOMA" OF BONE *

BY WILLIAM T. GREEN, M.D., AND SIDNEY FARBER, M.D.
(WITH THE ASSISTANCE OF LEO J. McDERMOTT, M.D.),
BOSTON, MASSACHUSETTS

*From the Departments of Orthopaedic Surgery and Pathology,
The Children's Hospital and the Harvard Medical School, Boston*

Since 1930 the authors have had the opportunity to study thirteen children who suffered from a disease process characterized by either solitary or multiple destructive lesions of bone, without clinical or roentgenographic evidence of visceral disease. These lesions appeared to be identical with what has been described, in the recent literature, as a new disease under the name "solitary granuloma" [6] and "eosinophilic granuloma" [5]. On the basis of pathological studies of material which included tissue removed at operation from patients to be discussed in this paper, Farber concluded that these benign destructive lesions of bone do not constitute a new disease, but represent rather one variant of a basic disease process, of which the clinical pictures known as Hand-Schüller-Christian disease, certain forms of xanthoma, and Letterer-Siwe disease are other examples.

Ten of the patients observed have been followed for a sufficiently long period to be included in a detailed analysis. Material was removed at biopsy in every case. Nine of these children have been examined recently. With one exception, all of the patients have been under observation throughout the clinical course of the disease. It is the purpose of this report to describe the important clinical findings in this group of patients, and to discuss briefly the pathological picture. A discussion of the nature of the disease process, with a presentation of the pertinent data, will appear elsewhere.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

CASE REPORTS

CASE 1. *C. D. (163932), male, aged two years. Multiple bone lesions. Minimal systemic manifestations. Two biopsies. Repeated roentgenotherapy. Follow-up after eight years: clinically well; no residua other than the healed defect of one vertebra.*

This patient was first seen at The Children's Hospital on August 18, 1932, with a complaint of a limp and pain in the right leg of two weeks' duration. Both the familial and personal history were otherwise completely negative. There was no known injury preceding the onset of symptoms.

The patient was a well developed and nourished child, whose significant physical findings were limited to tenderness and questionable thickening over the upper end of the right fibula, with palpable crepitus. His temperature was normal. Examination of the urine revealed no abnormal findings, nor did microscopic examination of the blood, except for a leukocytosis of 17,000. The intradermal injection of tuberculin gave no reaction, and the Hinton test for syphilis was negative.

Roentgenograms taken at this time showed an area of destruction, involving two centimeters of the upper end of the fibula, and a pathological fracture through the eroded area, without displacement (Fig. 1-A). There was a little new bone at the distal end of the area, but none in the immediate lesion. The roentgenographic and clinical impression at this time was that of an osteomyelitis with a pathological fracture, although other possibilities were considered.

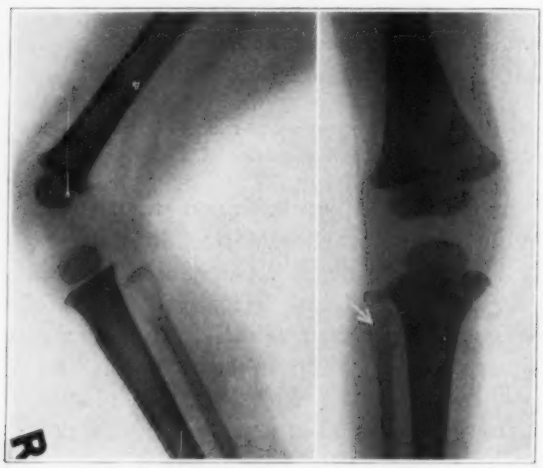

FIG. 1-A

Case 1. C. D. August 19, 1932. Roentgenograms show destructive lesion of the right fibula with a pathological fracture.

On August 22, the area was explored. A brownish-gray tissue occupying the site of the lesion was excised. There was no evidence of pus, and culture did not show any bacterial growth. The wound healed *per primam* and the postoperative convalescence seemed uneventful.

Three months after the original admission to the Hospital, the patient fell and complained of pain in his right arm near the shoulder. Examination showed tenderness in this area, although he seemed to be otherwise well. Roentgenograms taken at this time showed a new lesion in the shaft of the humerus some distance from the upper epiphysis, of a type similar to that seen in the fibula (Fig. 1-C). The fibula at this time showed evidence of considerable healing. Roentgenograms were taken of the rest of the skeleton, which showed many lesions in the skull, ribs, humeri, pelvis, and femora (Fig. 1-E). The boy seemed to be perfectly healthy with no symptoms other than the disability in his arm.

Laboratory studies at this time were not remarkable. On repeated examinations he still had a leukocytosis of from 15,000 to 18,000, with a normal differential count. The blood levels of calcium, phosphorus, non-protein nitrogen, and cholesterol were entirely normal, as were the serum protein, and the albumin-globulin ratio. Tests to evaluate kidney function did not demonstrate any abnormality, and Bence-Jones protein was not found in the urine on repeated examinations. The possibilities of neuroblastoma, hypernephroma, and Hand-Schüller-Christian syndrome were considered in the roentgenographic interpretation of the bones.

A biopsy of the left eighth rib was made at this time. Roentgenotherapy of the various bone lesions of the skull and the upper end of the humerus was begun on December 22, 1932; and of the pelvis, upper femora, and ribs on January 9, 10, and 11, 1933. Roentgenograms on February 12, 1933, showed the original lesions of the skull, humerus, ribs, and pelvis to be greatly improved. This was less than two months after the initial treatment to the skull and humerus, and indicates the rapidity with which healing may occur in this disease. Further treatment was given at this time to the skull in the areas involved, and to the humerus. On March 13, 1933, multiple new lesions had appeared in other areas of the skull, which were not visible in the roentgenograms one month previously. This, in turn, illustrates the rapidity with which destruction of

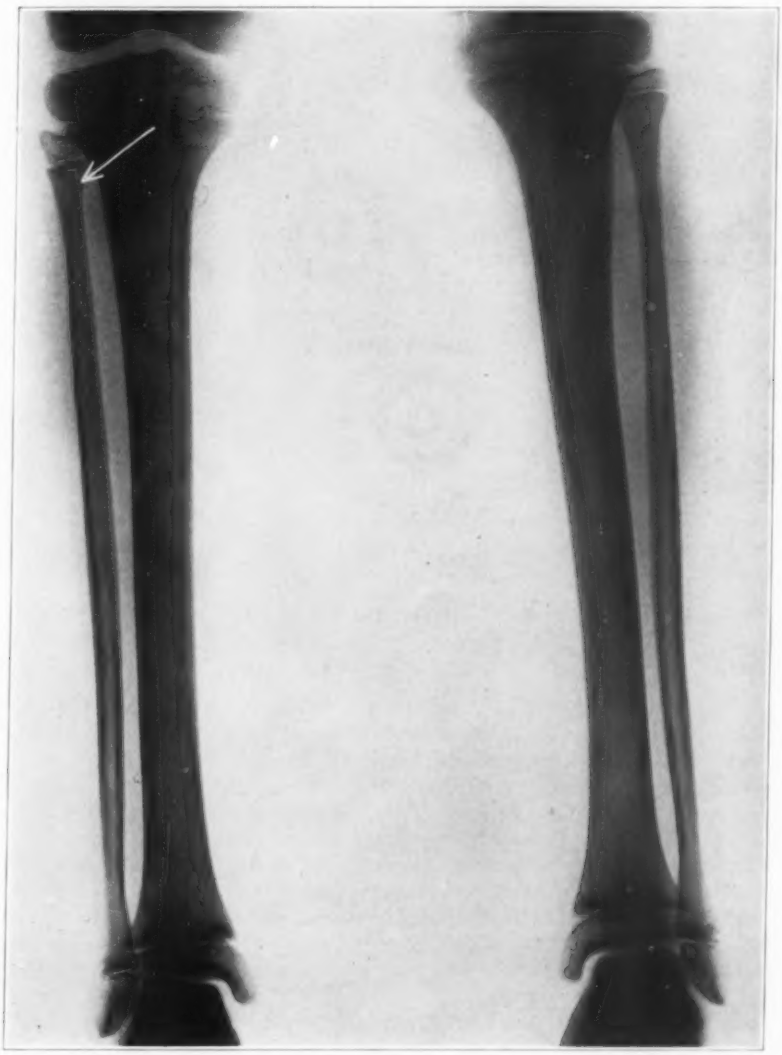

FIG. 1-B

Case 1. C. D. December 9, 1940. Follow-up roentgenogram eight years later shows the lesion to be completely healed. Compare the right fibula with the left.

bone may occur in the process. Throughout the course, the disease was characterized by the susceptibility of the lesions to roentgenotherapy and their rapid healing, and by the simultaneous development of new lesions in other areas. No new lesions were noted after August of 1933 (Fig. 1-G). The last roentgen treatment was in November 1933, which was fifteen months after the patient's original admission. In all, he had eleven sessions of therapy, with a dosage of from 400 to 800 roentgen units. Single fields, or two fields in the same area on successive days, were utilized. Roentgen examinations of June 1934, 1935, 1936, 1939, and 1940 showed no residua of the previous disease, except for a residual collapse of the ninth thoracic vertebra (Fig. 1-I). Clinical examination in 1940, eight years after the onset, showed normal findings. Throughout the course, the boy showed no evidence of systemic disturbances.

FIG. 1-C

Case 1. C. D. November 30, 1932. Roentgenogram shows the area of destruction in the right humerus as seen in the first roentgenogram of this area.

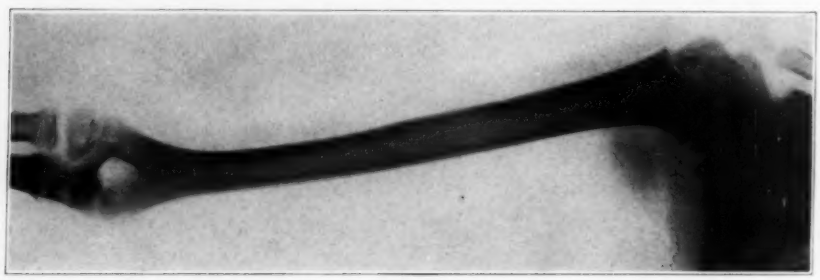

FIG. 1-D

Case 1. C. D. December 9, 1940. Follow-up examination shows that no trace of the lesion remains.

Tissue removed from the fibula at the first operation in 1932 revealed a process in which eosinophiles were so numerous in areas that they colored the field red with their cytoplasmic granules (Fig. 1-J). A considerable amount of fibrous-tissue repair of the process was evident. Many of the cells in the involved area were myelocytes. Plasma cells and occasional foci of polymorphonuclear leukocytes were also present.

Examination of material removed from the rib at the second operation revealed a type of tissue which was at first interpreted to be neoplastic. In the hematoxylin and eosin stains, the cytoplasm of large tumorlike cells was blue-gray in color, finely granular, and, in many instances, vacuolated. The nuclei were round to horseshoe-shaped. Large numbers of eosinophilic myelocytes and mature eosinophiles, and numerous lymphocytes were also present.

Interpretation of the lesions in 1932 was difficult because of the large number of cells of the myelocytic series, and a diagnosis of myelocytic myeloma, atypical, was made. Examination of tissue removed from other patients with a similar clinical problem, and consideration of the course of the disease process subsequent to the first biopsy led to reclassification of the process as a granuloma of the type under discussion in this paper.

CASE 2. *R. B. (222051), male, aged four years and seven months. Single lesion of ilium. Biopsy. One series of roentgenotherapy, 1500 roentgen units. Follow-up over two and one-half years after onset: clinically well; no residua.*

FIG. 1-E

Case 1. C. D. December 3, 1932. Many areas of destruction are present in the pelvis, as well as a lesion in the neck of the left femur.

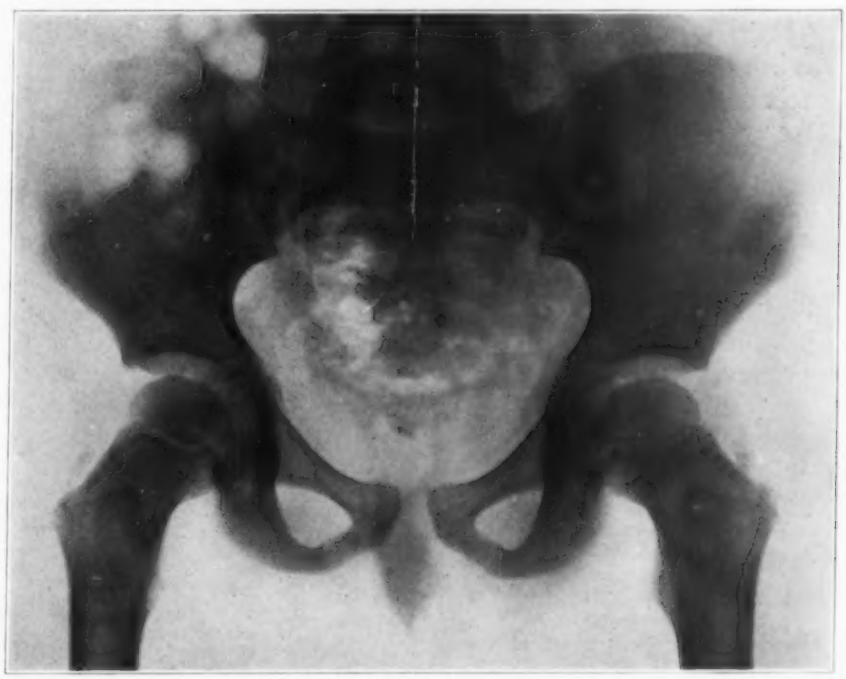

FIG. 1-F

Case 1. C. D. March 1, 1935. No evidence of the lesions remains.

FIG. 1-H

Case 1. C. D. March 1, 1935. The lesions are no longer evident.

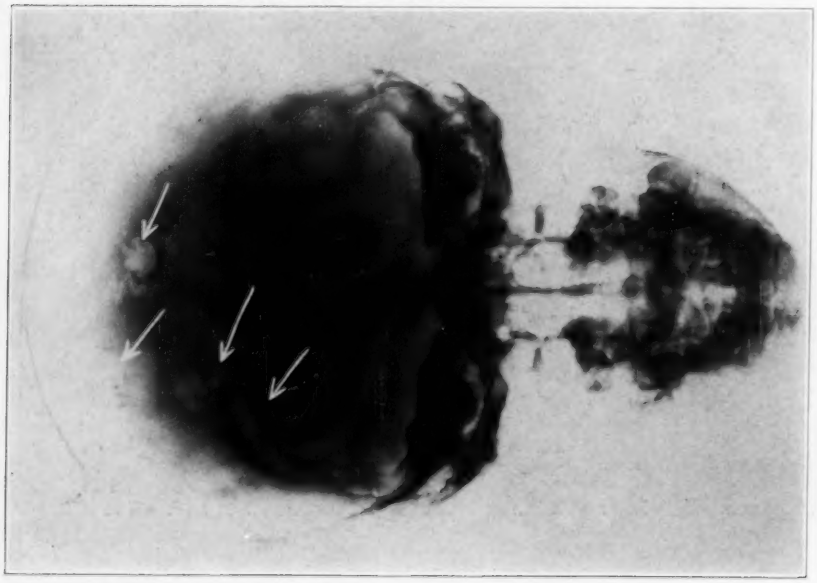

FIG. 1-G

Case 1. C. D. August 21, 1933. Multiple lesions of the skull are seen.

This boy was admitted to The Children's Hospital on May 16, 1938, with a complaint of limp and pain in the right hip of three weeks' duration, associated with a poor appetite. On examination, he was a well-developed and nourished boy who did not appear ill. He walked with a limp, and there was slight protective muscle spasm of the hip, as well as slight tenderness on the right side of the pelvis by rectal examination. There were no other positive findings.

Roentgen examination at this time showed a large area of destruction involving the ilium adjacent to the acetabulum (Fig. 2-A). No other lesions in the skeleton were demonstrable.

Laboratory studies gave essentially normal values. He did have a white-blood-cell count of 10,700, with a not unusual differential count. Blood calcium, phosphorus, phosphatase, cholesterol, blood fat, and total protein were all within normal limits. There was no Bence-Jones body in the urine.

Exploration of the lesion was carried out on May 25, 1938. The area of bone destruction was filled with a dark reddish-gray, gelatinous tissue which was moderately vascular, and was easily curetted from the bone. Histopathological examination revealed a process identical with that found in Case 1. The patient was given one series

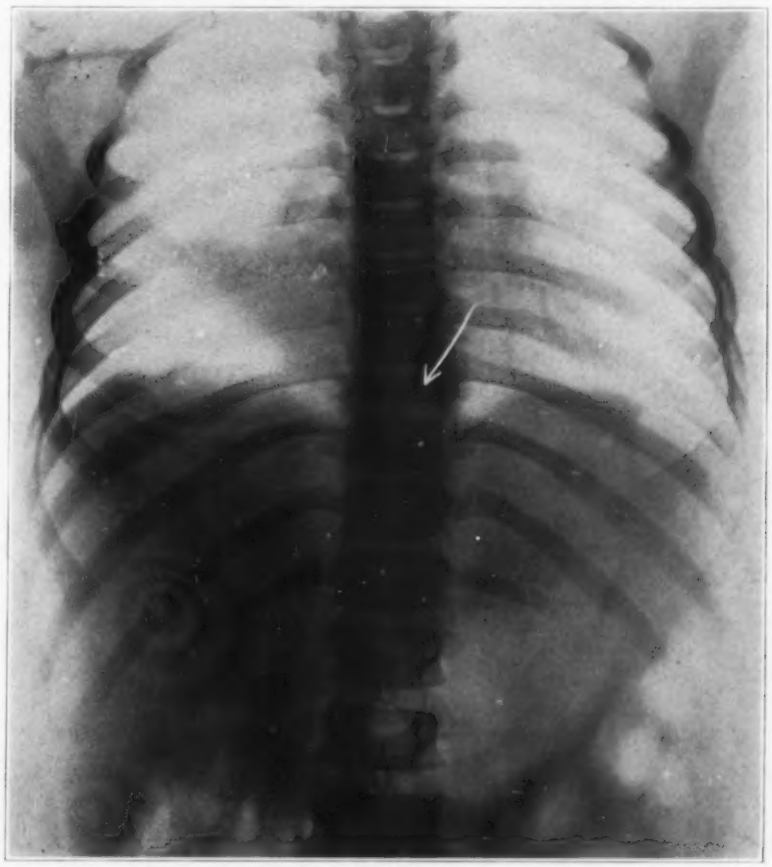

FIG. 1-I

Case 1. C. D. July 21, 1939. The only visible residuum of many bone lesions is deformity of the ninth thoracic vertebra, which has remained unchanged for four years. The many ribs previously involved show no evidence of the disease.

of x-ray radiation from June 8 to June 14, with daily exposure of 250 roentgen units, using two different fields. The total amount given was 1500 roentgen units. The boy

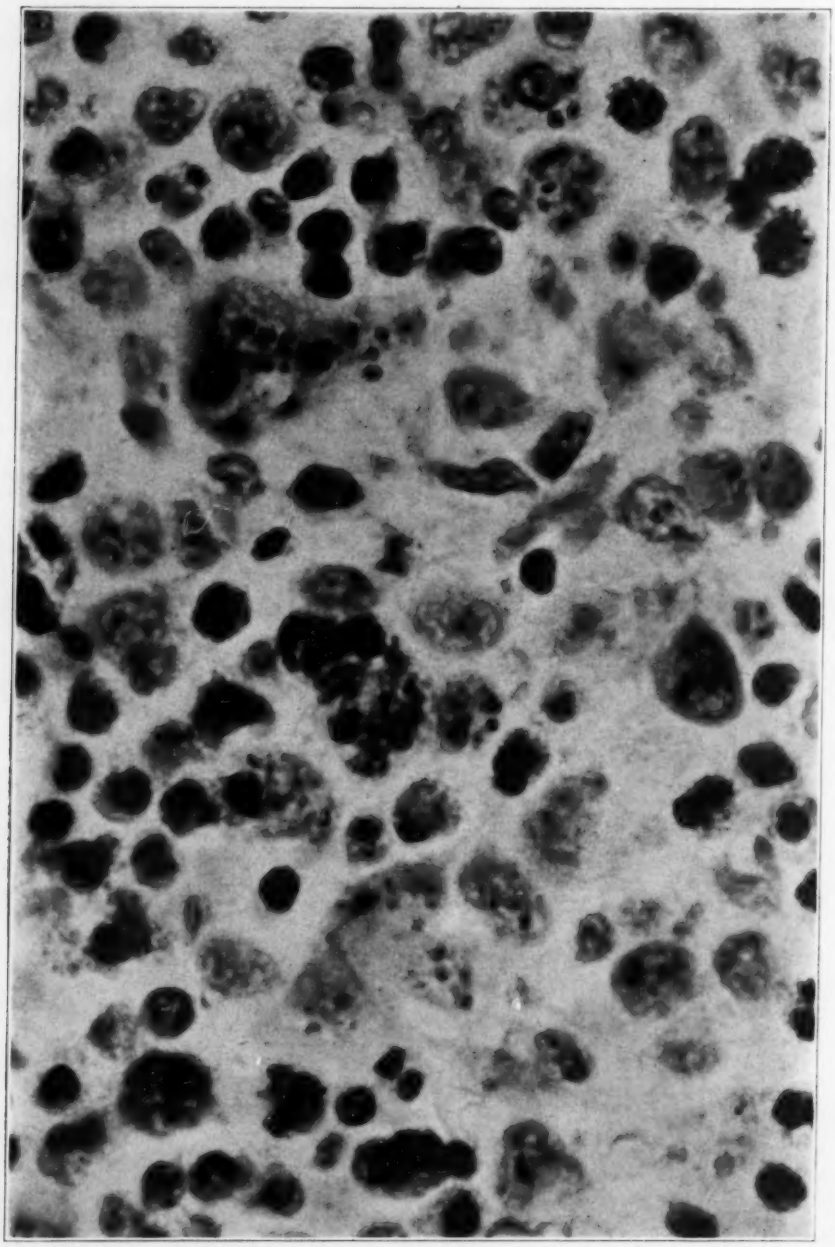

FIG. 1-J

Case 1. C. D. Photomicrograph (×500) of a section from the head of the fibula. Eosinophiles are a prominent feature of the granulomatous process. There are numerous large mononuclear phagocytes, many of which have a cytoplasm ranging from granular to finely vacuolated. (Hematoxylin and eosin stains.)

FIG. 2-A

Case 2. R. B. May 16, 1938. A large defect of the right ilium adjacent to the acetabulum was the only bone lesion seen in the roentgenograms of this patient.

FIG. 2-B

Case 2. R. B. December 30, 1940. The lesion is healed.

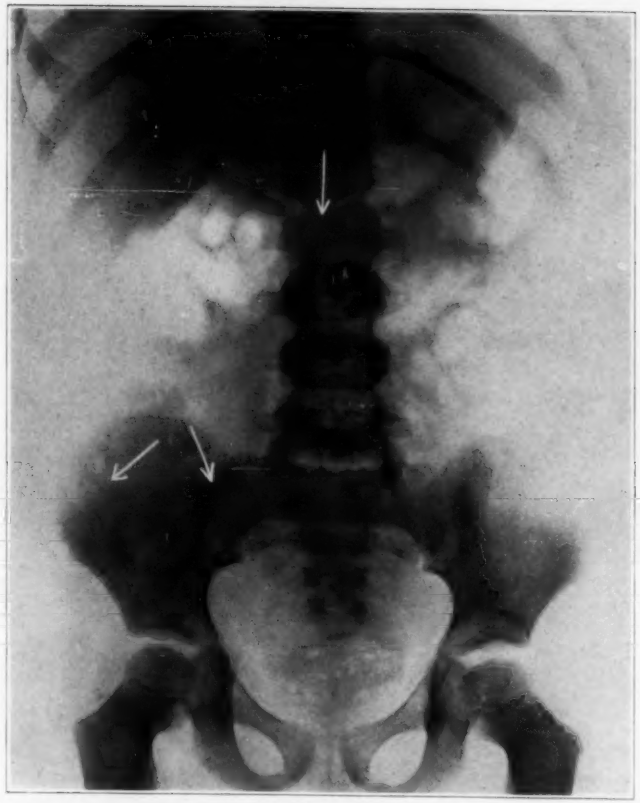

FIG. 3-A

Case 3. R. O. September 16, 1936. Multiple lesions involving the second and third lumbar vertebrae and the right ilium are seen.

FIG. 3-B

Case 3. R. O. February 9, 1937. Lesions of the vertebrae were untreated. Note new lesion in the eleventh thoracic vertebra with collapse of the vertebra, and surrounding soft-tissue shadows resembling a tuberculous process. Lesions of the ilium are healed.

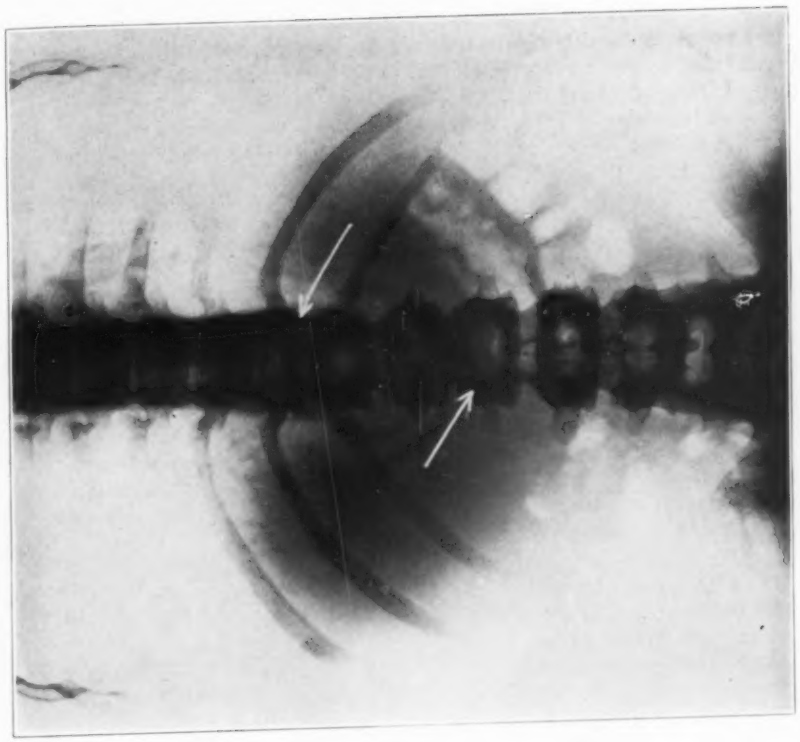

FIG. 3-D
December 14, 1940

FIG. 3-C
July 17, 1939

Case 3. R. O. Lateral and anteroposterior views of the spine show residual defects of the vertebrae without evidence of activity. Earlier roentgenograms showed the same status. No other skeletal defects remain.

was kept in traction for five weeks, and was allowed to walk after nine weeks. He walked without a limp in September of that same year, three and one-half months after the biopsy.

By roentgenograms, the defect showed definite healing two months after the biopsy, and six weeks after the therapy had been given. Roentgenograms taken one year later showed marked filling-in of the defect.

Examination December 30, 1940, showed a tall, husky boy who seemed entirely well. Roentgenograms at this time showed the defect to have been obliterated.

CASE 3. *R. O. (205871), male, aged four and one-half years. Multiple lesions. Two biopsies. Repeated roentgenotherapy. Follow-up four years after the onset: clinically well with healed vertebral deformities.*

This boy was admitted on September 16, 1936, with a complaint of pain in his back and right arm of four months' duration. His appetite had been poor, and he had lost some weight. His familial and past history were not important.

Physical examination showed a somewhat pale, well-developed boy who presented a mild kyphos of the upper lumbar vertebrae, with muscle spasm on forward flexion. There was atrophy of the muscles of the right arm, unassociated with tenderness or muscle spasm. He was not particularly ill. His temperature was normal.

Roentgenographic examination showed destructive processes in the right ilium, the second and third lumbar vertebrae (Fig. 3-A), right humerus, right scapula, and skull.

Laboratory determinations were essentially normal:

Red blood cells—4,700,000
Hemoglobin—90 per cent.
White blood cells—11,300
Polymorphonuclear neutrophiles—68 per cent.
Lymphocytes—25 per cent.
Monocytes—3.5 per cent.
Eosinophiles—3.5 per cent.
Blood chemistry:
Calcium—9.6 milligrams per 100 cubic centimeters of serum
Phosphorus—4.0 milligrams per 100 cubic centimeters of serum
Phosphatase—0.582 Kay units
Cholesterol—171 and 139 milligrams per 100 cubic centimeters on two determinations
Serum protein—6.7 milligrams per 100 cubic centimeters
Fat—1.49 grams and 0.75 grams per 100 cubic centimeters on two determinations
Phospholipid phosphorus—10 milligrams per 100 cubic centimeters
Intradermal tuberculin test—negative
Hinton test for syphilis—negative.

A biopsy with removal of all recognizable pathological tissue was made on the larger lesion of the ilium on September 22, 1936, and on a lesion of the humerus on October 10, 1936. Bacterial culture gave no growth. Histopathological examination in each instance showed a healed and healing granulomatous process, with small foci of lipophage and other large mononuclear infiltration.

The spine was supported by a plaster body jacket, and x-ray radiation of 400 roentgen units was given to the right scapula and humerus on November 4 and 5, 1936, utilizing two different fields.

Roentgenograms taken December 15, 1936, showed marked healing of the lesions in the treated areas, with considerable healing of the lesion in the ilium, which had been curetted, but which had not had roentgenotherapy. Roentgen examination on February 9, 1937, showed the lesion in the humerus to be completely healed, and that of the ilium practically healed. The untreated lesions of the spine showed increased destruction, and new lesions had developed in other vertebrae, with almost complete collapse of the

body of the eleventh thoracic vertebra, which showed an associated spindle-shaped shadow of the type seen in a tuberculous process (Fig. 3-B).

Roentgenotherapy was given to all recognizable lesions in February of 1937, and the child was maintained in a plaster body shell. The therapy to all areas was repeated on March 23, 1937, and to the thoracolumbar spine on April 24 and May 25, 1937.

The lesions responded rapidly. The child was allowed out of the shell and given a long spinal back brace in September of 1937, which he wore during his convalescent period. At no time was the boy generally ill, nor did he have any temperature elevation.

Examination in December 1940 showed the patient to be clinically well. There were residual deformities of the vertebrae without clinical signs (Fig. 3-D).

CASE 4. *J. K. (196152), male, aged seven years and two months. Single cystlike area in humerus without symptoms. Two biopsies. Five year follow-up examination: well with no residua.*

This patient was admitted September 30, 1935, for treatment of a cystic-appearing area in his right humerus, which had been discovered when a roentgenogram of his chest had been taken. There had been no complaints referable to the arm. The family history gave no significant information. His past history was marked by allergic manifestations, including eczema as an infant, and asthma which had persisted.

Physical examination of the arm was negative, as was the general examination at the time of admission. Roentgenograms of the skeleton revealed no defects other than a large oval area in the shaft of the humerus, about six centimeters from the upper epiphyseal plate, which was interpreted as "a solitary bone cyst" (Fig. 4-A). His temperature was normal.

In the laboratory examination, the routine urinalysis gave essentially normal values. The calcium and phosphorus of the blood were within normal limits on repeated examinations. He did have an eosinophile count of 3 per cent. on admission, and at one time in his course, during an asthmatic attack, this reached 8 per cent. At all other counts, the average was 1 per cent. Total blood lipid was not determined until the lesion was practically healed, and was 0.930 grams. Intradermal tuberculin test in dilution of 1:1000 was negative, as was the Hinton test for syphilis.

FIG. 4-A

Case 4. J. K. September 28, 1935. The lesion of the humerus suggests a solitary bone cyst.

FIG. 4-B

Case 4. J. K. December 30, 1940. Roentgenogram on follow-up examination shows no residual defect.

FIG. 5-B

Case 5. P. F. July 17, 1939. At follow-up examination, no residua of defects are seen.

FIG. 5-A

Case 5. P. F. March 7, 1932. There is one very large defect in the frontal bone, with a smaller lesion above it.

At operation on October 4, 1935, the area in the humerus was explored and found to be filled with "yellow caseous material which was thoroughly curetted until normal bone

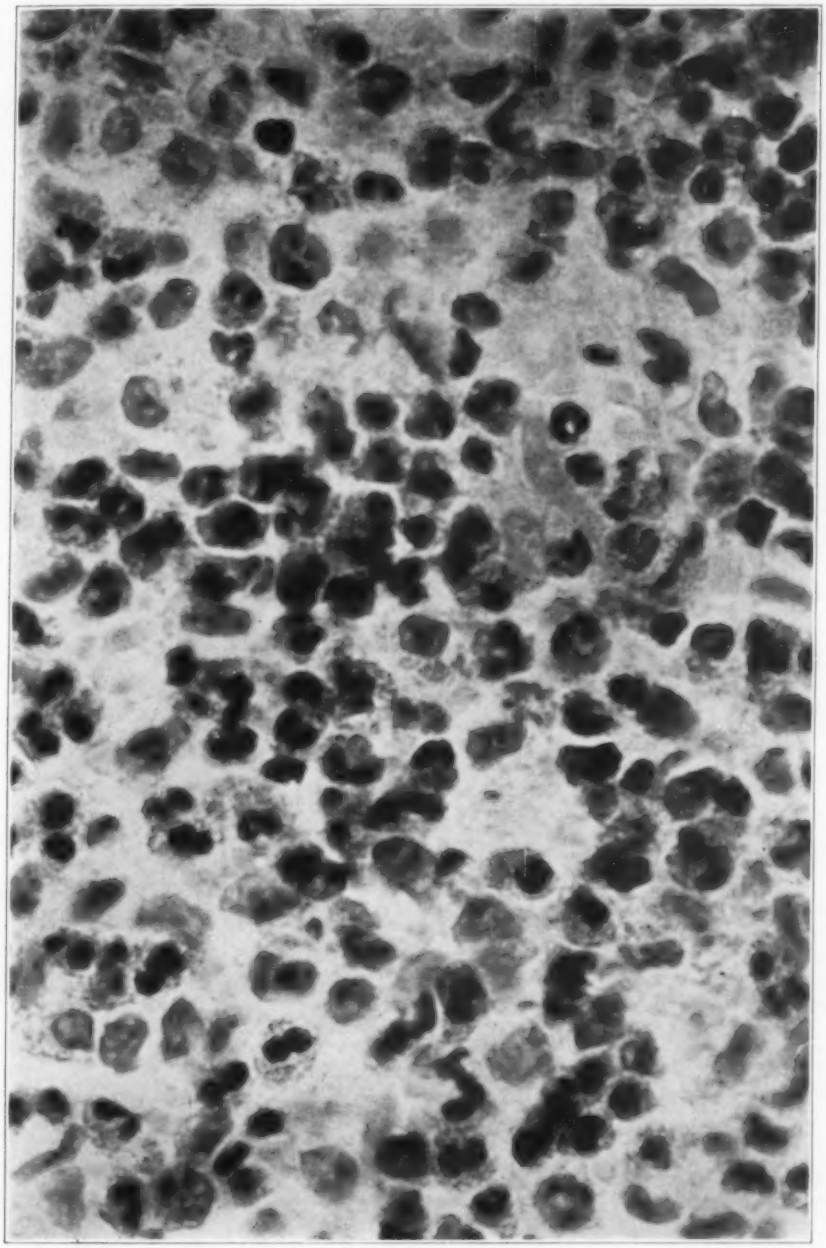

FIG. 5-C

Case 5. P. F. Photomicrograph (×500) of the tissue removed from the defect in the skull. The process is a granulomatous one in which large numbers of eosinophilic cells are found. In addition, large mononuclear cells with pale cytoplasm are scattered throughout the section. (Eosin and methylene-blue stains.)

was obtained". The wound healed *per primam*. The histopathological findings were similar to those found in the other cases, except for a larger proportion of "foam cells", with eosinophiles not a prominent finding. Culture of the tissue from the area did not reveal any bacterial growth.

Eight weeks later, roentgenograms showed considerable healing, but subsequently the area remained mottled. In October 1936, roentgenotherapy was given to this area through two different fields on successive days.

Since the healing was incomplete, a second curettage of the area was done on May 13, 1937. Microscopic examination showed fibrous-tissue replacement of the disease process.

The defect gradually became obliterated. At a follow-up examination in December 1940, roentgenograms showed complete healing, and there were no other recognizable lesions (Fig. 4-B). Clinically he was well, except for infrequent attacks of asthma.

CASE 5. *P. F. (158189), male, aged ten and one-half years. Two lesions in the skull. Biopsy. Roentgenotherapy. Follow-up over eight and one-half years after onset: clinically well, with no residual defect.*

This patient was admitted March 7, 1932, with the complaint of swelling of the right side of his forehead of twenty-five days' duration. There were no other complaints. There was no known antecedent illness or injury.

Physical examination showed a well-developed and nourished boy with a soft swelling the size of a plum over the right frontal region. The right supra-orbital region seemed slightly less prominent than the left. Except for carious teeth, the physical examination did not reveal any significant abnormalities. There were no abnormal neurological signs.

In the laboratory examination, the blood and urine showed normal findings. There was no eosinophilia. Blood calcium, phosphorus, cholesterol, and non-protein nitrogen were all normal.

Roentgenograms showed a large circular defect, about four centimeters in diameter, in the right frontal bone just lateral to the mid-line above the orbit. There was another lesion about one and five-tenths centimeters in diameter just above the large one (Fig. 5-A). There were no other bone defects demonstrable in the skeleton.

At operation on March 10, 1932, a portion of the tissue was removed for microscopic examination. Culture of this tissue did not give bacterial growth.

The histological picture was typical of the other cases,—a granulomatous process with numerous lipophages, and with foci of eosinophilic infiltration a prominent feature (Fig. 5-C).

On March 18, 1932, x-ray radiation was given in an approximate dosage of 300 roentgen units, and this was repeated at monthly intervals until a total of six treatments had been given. About 50 per cent. epilation was produced. Roentgenograms taken in July 1932 showed considerable healing of the process. This healing was progressive, and on follow-up examination, over eight and one-half years after the onset, the patient was found to be entirely well clinically. There were no residual defects in the skull (Fig. 5-B).

CLINICAL FEATURES

The clinical course presented by these five patients is representative of that observed in all cases in which the lesions were confined to the skeleton. The process in all these instances was characterized by destructive lesions of bone, either single or multiple, associated almost uniformly with few significant general manifestations.

The ages of the ten patients varied from eleven months to ten years and eleven months. Nine of the ten patients were males; the significance of this sex difference in this series cannot be commented upon at this time. Four patients had single bone lesions, and six multiple lesions.

TABLE I

BONES AFFECTED *

Bones	Single Lesion (4 Cases)	Multiple Lesions (6 Cases)
Skull	2	6
Pelvis	1	5
Scapula		2
Rib		21
Vertebra		8
Face		2
Mandible		2
Femur		6
Tibia		2
Fibula		1
Humerus	1	7

* Flat bones predominate.

The average number of multiple lesions was sixteen, with the maximum of twenty-five in one patient.

The lesions of the bone, as seen by roentgenography, were variable as to contour, being round, oval, or irregular in outline. They gave a punched-out effect, and did not expand the cortex, though they did on occasion erode through it. There were minimal reactive changes in the bone itself, except in the healing phase. The areas often developed very rapidly, and frequently, after roentgenotherapy, healed equally rapidly.

The distribution and appearance of the process in those with multiple lesions resembled that seen in metastatic malignancy or multiple myeloma, and were identical with the picture seen in Hand-Christian-Schüller disease. Flat and irregular bones predominated (Table I). Of the bones of the extremities, those closest to the trunk were most commonly involved; in no instances were the distal ends of the tibia, fibula, radius, and ulna, or the bones of the hands and feet affected.

The distribution of the lesions in those with multiple areas may be seen in Table I. The maximal number of lesions which were recognized in one patient was twenty-five. In the four patients with solitary lesions, the bones affected were the ilium, humerus, and, in two instances, the skull.

The sites in the individual bones had no particular pattern. They were frequently near an epiphysis, but they were occasionally in the middle of the shaft or in the epiphysis itself. In single lesions, the roentgenographic appearance, as seen in Case 4 (Figs. 4-A and 4-B), might be exactly that of a solitary bone cyst, and, if the epiphysis is involved, a giant-cell tumor might be suggested. In this series, however, lesions of the epiphyses have always been accompanied by other lesions. In one instance of vertebral involvement, there was an associated spindle-shaped soft-tissue shadow resembling that seen in a tuberculous lesion.

The symptoms were mainly those due to the local lesions. Pain and swelling were the most common complaints. Swelling was usually the first symptom when the skull was the site of the initial lesion, whereas pain was the usual presenting symptom in lesions of other areas. The pain was not of significant degree, except in those instances in which the lesions were adjacent to a joint, or in which a pathological fracture occurred. Many of the lesions existed without any complaints or physical signs. In one patient (Case 4), with a single lesion of the shaft of the humerus, the area was discovered accidentally when films of the chest were taken for another condition. Of other symptoms due to the local process, there were two instances of unilateral exophthalmos of mild degree from involvement of the orbital plate, and one of loss of teeth associated with a lesion of the mandible.

Evidences of general illness when the patients were first seen were few. Four had no complaints of a general type on admission, and seemed to be perfectly well except for the presence of the local lesions. Irritability, loss of weight, and anorexia were noted (each in two patients), but these were not marked.

In nine of the ten children, the general health was good throughout the course, except for a moderate anaemia which came on after roentgenotherapy in four instances. In no instances were there any suggestions of diabetes insipidus, dwarfism, mental deterioration, or symptoms referable to the central nervous system. Headache was noted at some time in three of the patients. Fever, attributable to the disease, was not present.

In considering possible etiological factors, attention was given to the history of antecedent infection and trauma. In no instance was it suggested that a preliminary infection was related to the disease, and in only one instance was there a history of trauma. This patient was alleged to have been struck over his right eye with a baseball, approximately three weeks before a swelling was noted in the same area. After the blow, the patient lost consciousness for several minutes. The lesion of the skull was quite large six weeks after the alleged injury, and the question arose as to whether the severity of the trauma might have been apparent rather than real, because of a lesion which was already in existence.

Otani and Ehrlich felt that trauma played some part in the etiology. As evidence, they presented the fact that Schairer felt that injury was the initiating factor in his two cases, and that a history of trauma was present in three of their five cases in which historical information was available. A history of trauma was present in only one of the patients for whom they gave a detailed history. In this instance the ascribed injury was a pull on the arm two weeks before admission, followed by pain and inability to move the arm. Roentgenographic examination on admission was reported to show "an area of bone destruction, fairly extensive, involving the glenoid fossa, and the neck of the scapula and extending along the

outer border". This history would suggest that the trauma merely precipitated symptoms in an already existing lesion, and was not an etiological factor.

The course of one patient in the authors' series differed from that of the others. When admitted, this child had had the disease seven months, and showed a draining sinus in front of the left ear which had developed after operative drainage of what was thought to be an abscess. Despite this, the child was well developed, well nourished, and did not seem particularly ill. He did have a relatively severe anaemia; the red count was 3,500,000 with a hemoglobin of 65 per cent. He presented multiple lesions of the skull, ilium, left femur, humeri, and ribs, which in roentgenographic appearance were similar to those seen in other cases. Tissue removed from one of the lesions presented a histological picture identical to that seen in the other cases. The lesions reacted less well to roentgenotherapy than in many cases, although definite healing in the areas which were treated was noted coincident with the appearance of new lesions in other regions. After fairly extensive roentgenotherapy, a severe anaemia and leukopenia developed, for which blood transfusions were given. The patient seemed to be in good condition at the time of his discharge. He did not return to the Hospital, but it has been established that he died three months later. No details are available.

Laboratory studies were not particularly revealing. Leukocytosis was present on admission in six of the ten cases, averaging 15,800 in those instances where it was elevated. In one instance there was an eosinophilia of 6 per cent., but this followed roentgenotherapy. In three other patients the percentage of eosinophiles was 3 per cent. on one determination, but at a lower level on all other occasions. In another patient, 8 per cent. eosinophiles were present during an asthmatic attack, but his differential blood count was within normal limits at other times. Lichtenstein and Jaffe pointed out the presence of eosinophilia of from 4 per cent. to 10 per cent. in their cases.

Chemical examination of the blood revealed the phosphorus, calcium, and phosphatase to be normal in all instances where such determinations were made. The total lipid of the blood was above one gram in four of the nine cases on one determination, but when the examination was repeated, normal figures were obtained. The phospholipid phosphorus of the blood was normal in the eight cases in which it was studied.

The values for blood cholesterol and cholesterol ester showed no significant variations from the accepted normal. The total protein of the blood, as well as the albumin-globulin ratio, was determined in several instances, and in all the findings were normal. The urine was examined for Bence-Jones protein and in no instance was it found. The intradermal tuberculin test and the Hinton test for syphilis were done in all cases, with negative findings. Culture of the biopsy site, in many instances anaerobically as well as aerobically, gave no bacterial growth.

PATHOLOGY

The pathological picture presented in the different cases showed considerable variation. As tissue removed at operation accumulated in the course of this study, stages in what appeared to be the life history of the process could be defined. The destructive lesion in bone is essentially a granulomatous one, with variations which appear to depend upon the duration of the disease process, the degree of destruction of bone, and the amount of repair. What may be interpreted as the *early* lesion consists of areas of bone destruction infiltrated by large numbers of cells, most of which are either eosinophiles or large mononuclear cells which are actively phagocytic. The eosinophiles are either mature leukocytes or, as is frequently the case, eosinophilic myelocytes. They may be gathered in large clumps or masses in such a way that the field is discolored a bright red by their presence, or they may be scattered diffusely through the entire section. Accompanying the eosinophiles are variable numbers of plasma cells, lymphocytes, and small foci of polymorphonuclear leukocytes unassociated with bacterial infection or abscess formation. The large mononuclear cells vary considerably in size. Usually the large mononuclear cells have round to oval or horseshoe-shaped nuclei, and possess cytoplasm which is either coarsely granular, definitely vacuolated, or frankly "foamy" in character. Frequently present in the large mononuclear cells are fragments of eosinophiles or polymorphonuclear leukocytes, bits of intact bone, or unrecognizable debris. Either the foci of eosinophiles or masses of large mononuclear cells may dominate the picture. Often gathered around the masses of large mononuclear phagocytes, with or without vacuolated cytoplasm, there may be found large numbers of myelocytes, not all of which are eosinophilic, giving a suggestion of intense stimulation of the bone marrow which, when first seen, may suggest myelocytic myeloma.

In a somewhat *older* stage of the disease process, eosinophiles are no longer present. Now large mononuclear cells, most of which are vacuolated, represent the most common cell found, and fibroblastic ingrowth is evident. A little later stage of this same process may show complete vacuolization of the large mononuclear cells—which may now be called lipophages—giving an appearance typical of the "foam" cells of xanthoma. In a still later stage of the disease the entire granulomatous process is replaced by connective tissue, which in turn will be transformed into bone.

Scharlach-R stains demonstrate in the early stage of the disease, even in areas where eosinophilic infiltration is most marked, a large amount of stainable lipid which is sometimes doubly refractile. This material does not stain positively by the Smith-Dietrich method for sphyngomyelin. In the somewhat older lesions when lipophages are more common, a larger amount of stainable lipid may be demonstrated by the Scharlach-R method. The impression is gained from the study of a number of specimens that, as the lesion progresses and the area of

bone destruction is being repaired, lipid is released in increasingly large amounts, and is taken up by large mononuclear phagocytes (lipophages).

In none of the material available for study was there evidence of a bacterial infection. Sections of tissue stained by appropriate methods disclosed no bacteria either within or between the cells. A small number of animal-inoculation studies revealed no evidence of a living agent, and attempts to culture a bacterium by anaerobic, aerobic, or partial-tension techniques were unsuccessful. A few efforts were made to demonstrate the presence of a possible virus, but insufficient studies have been made to exclude its presence.

TREATMENT AND PROGNOSIS

The treatment was originally evolved by pure empiricism. It was found that most of the lesions responded to roentgen radiation in relatively small doses. In other instances, they have healed following partial excision and curettage. Healing has occurred spontaneously in two lesions of this series, both of vertebrae, but in each instance there was residual deformity.

The roentgen radiation in the earlier cases was essentially that of a technique involving a single dose of 400 roentgen units, which produced a mild erythematous reaction. A typical treatment may be recorded as follows: 160 kilovolts, five milliamperes, at a distance of forty centimeters, with a filter of four millimeters of aluminum. Frequently this dosage was given to the same area through another field one month later. On occasion, however, at the original treatment, the dosage above was used on successive days.

The technique utilized in the later cases is typified by Case 2, in which a total of 1500 roentgen units was given through two fields, in divided doses over a six-day period. The details of the daily exposure were recorded as: 160 kilovolts, five milliamperes, at a distance of forty centimeters, for twenty minutes. The filter was one-fourth of a millimeter of copper and one millimeter of aluminum.

No significant difference in result has been noted from the two techniques. Twelve was the maximal number of treatments to any one bone. These were given, over a period of twenty-one months, to the skull (Case 1), where new lesions were appearing as the old ones healed. In cases with multiple lesions, there is a distinct advantage in keeping the dosage to any one area at a relatively low level.

In five of the patients, lesions appeared in new areas while the original lesions were being treated. In one instance, a new lesion appeared two years and eight months after the known onset of the disease. All lesions were interpreted by roentgenograms as completely healed on an average of one year and seven months after admission. Often in a few months the healing was so complete that the site of the former lesion could not be recognized.

A recent examination of the nine living patients of this series revealed

TABLE II

SUMMARY OF ALL CASES

Hospital Case No.	Name	Age	Sex	Admitted	Duration of Symptoms	Lesions	Last New Lesion †	Healed *	Follow-Up *
150020	R. B.	4 years, 4 months	F	Apr. 15, 1933	3 weeks	Single	None	1 year, 6 months	7 years, 8 months
196152	J. K.	7 years, 2 months	M	Sept. 30, 1935	?	Single	None	2 years, 7 months	5 years, 3 months
202932	K. Mc.	10 years, 11 months	M	June 8, 1936	1½ months	Single	None	11 months	4 years, 6 months
222051	R. B.	4 years, 7 months	M	May 16, 1938	3 weeks	Single	None	1 year, 2 months	2 years, 7 months
143166	J. T.	3 years, 8 months	M	Oct. 6, 1930	1½ years	Multiple	1 year, 2 months	2 years, 6 months	10 years, 3 months
158189	P. F.	10 years, 6 months	M	Mar. 7, 1932	1 month	Multiple	None	1 year, 2 months	8 years, 9 months
163932	C. D.	2 years, 1 month	M	Aug. 18, 1932	2 weeks	Multiple	1 year	2 years, 7 months	8 years, 4 months
183732	T. N.	11 months	M	July 16, 1934	2 months	Multiple	8 months	1 year, 3 months	6 years, 5 months
205871	R. O.	4 years, 6 months	M	Sept. 16, 1936	4 months	Multiple	5 months	10 months	4 years, 3 months
194161	N. G.	2 years, 4 months	M	July 20, 1935	7 months	Multiple	11 months	Dead	Dead
Average		5 years, 1 month			4 months			1 year, 7 months	6 years, 5 months

* Period of time after admission.

† Lesions developing while under observation.

that all seemed to be entirely well (Table II). There were residua in three instances: One patient had an adentulous jaw, and in two others residual deformities of vertebrae were seen in the roentgenograms, without symptoms or recognizable clinical deformity. The follow-up interval averaged six years and five months after the original admission,—the longest being over ten years; the shortest, two years and seven months.

One patient died. He was not followed throughout the course of the disease and the cause of his death is not known.

Certainly the prognosis for healing of the individual bone lesions is good, but if the suggested relationship of this condition with Hand-Schüller-Christian disease and Letterer-Siwe disease exists, the general prognosis at the outset should be guarded. The authors have seen a fatal outcome in patients whose bone lesions seemed to be identical with those in this series, but who in addition had visceral lesions.

DIAGNOSTIC CONSIDERATIONS AND COMMENT

This process must be considered in differential diagnosis whenever destructive lesions of bone, either single or multiple in occurrence, are encountered. The lesion has been noted much more commonly in children than in adults. One of the authors has had the opportunity to study specimens removed at operation from several adults. It is probable that many more examples of this disease will be recognized as knowledge concerning its clinical and pathological characteristics becomes disseminated.

When the lesion is present in solitary form, clinical and roentgenographic differentiation from osteomyelitis, tuberculosis, syphilis, solitary bone cyst, and giant-cell tumor must be considered. When multiple lesions are present, multiple myeloma, metastases of neuroblastoma or of lymphoma, and osteitis fibrosa cystica of the generalized form are some of the differential considerations in interpretation of the roentgenograms. The problem varies with the number of lesions and their sites.

The similarity in roentgenographic appearance of the lesion under discussion and tuberculosis, is suggested by the destructive nature of the process without the formation of new bone. In one instance in this series, a lesion of a vertebra was associated with a paravertebral shadow similar in outline to a tuberculous process. The tuberculin test may be used as an aid in making the diagnosis of tuberculosis. When syphilis is considered, the Hinton test may be of value.

In certain instances it is impossible to differentiate the solitary form from a bone cyst except by histological examination. The same may be said of osteomyelitis, although osteomyelitis usually is accompanied by more evidences of generalized illness—such as fever, pain, and reaction in the surrounding soft tissues—as well as roentgenographic evidences of new-bone formation.

Multiple myeloma will be suggested by the roentgenographic manifestations of the multiple form of the disease. Laboratory studies, such as a search for the Bence-Jones protein and the albumin globulin ratio,

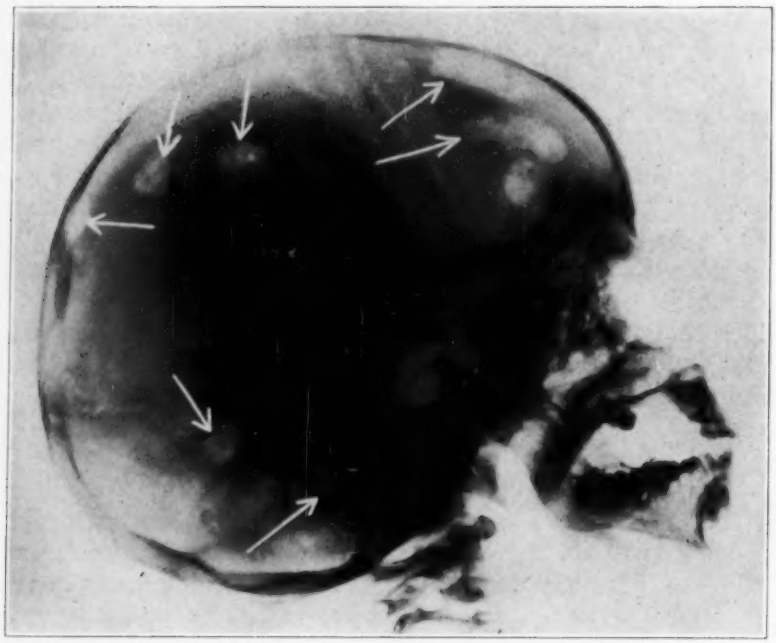

FIG. 6-A

November 16, 1928. E. T., male, with a classic picture of Hand-Schüller-Christian disease. Note the areas of destruction in the skull. This x-ray was taken about seven weeks after admission, and was chosen since it shows the lesions more clearly. (*Reproduced through the courtesy of the American Journal of Roentgenology and Radium Therapy*[8].)

FIG. 6-B

July 3, 1930. Note the areas of destruction in the ilium.

may be helpful on these occasions. True multiple myeloma has not been encountered in a fairly large experience with tumors in infants and children in this Hospital.

Pain is usually a more prominent feature in instances of Ewing's tumor than in this disease. In Ewing's tumor, also, the area of involvement as shown in the roentgenograms is usually not so circumscribed, and there is likely to be considerable subperiosteal new-bone formation. Multiple punched-out defects of bone may be found in leukaemia, but these defects are usually smaller and more generalized than in the disease under consideration. Hematological study should be sufficient to exclude the diagnosis of leukaemia. The diagnosis of metastatic lesions in the skeleton from a neuroblastoma may be made with certainty by the finding of the primary tumor. The bone changes of hyperparathyroidism are accompanied usually by significant alterations in the levels of calcium, phosphorus, and phosphatase in the blood. No alterations of these values are found in the disease under consideration, nor are there any generalized skeletal changes such as occur in hyperparathyroidism. The bone lesions of the disease process under consideration have an identical roentgenographic appearance with those of Hand-Schüller-Christian disease.

A general statement may be made that, although the disease may be suspected on clinical and roentgenographic grounds, a positive diagnosis is possible only when clinical and roentgenographic data are correlated with the histological examination of biopsy material. Positive recognition of the nature of this disease at any one of the several stages of its development, on histological grounds alone, is possible only if the variations in the life history of the process are known. Before the granulomatous character of the lesion was recognized, diagnoses such as a "pe-

FIG. 6-C FIG. 6-D

E. T. Photographs of patient at the age of nine years, six and one-half years after the onset of symptoms. The patient is now a blind, mentally retarded dwarf.

culiar form of osteomyelitis", or a "neoplasm, probably an atypical myelocytic myeloma", were made by many pathologists. Such diagnoses were made by one of the authors (S. F.) on material removed from the

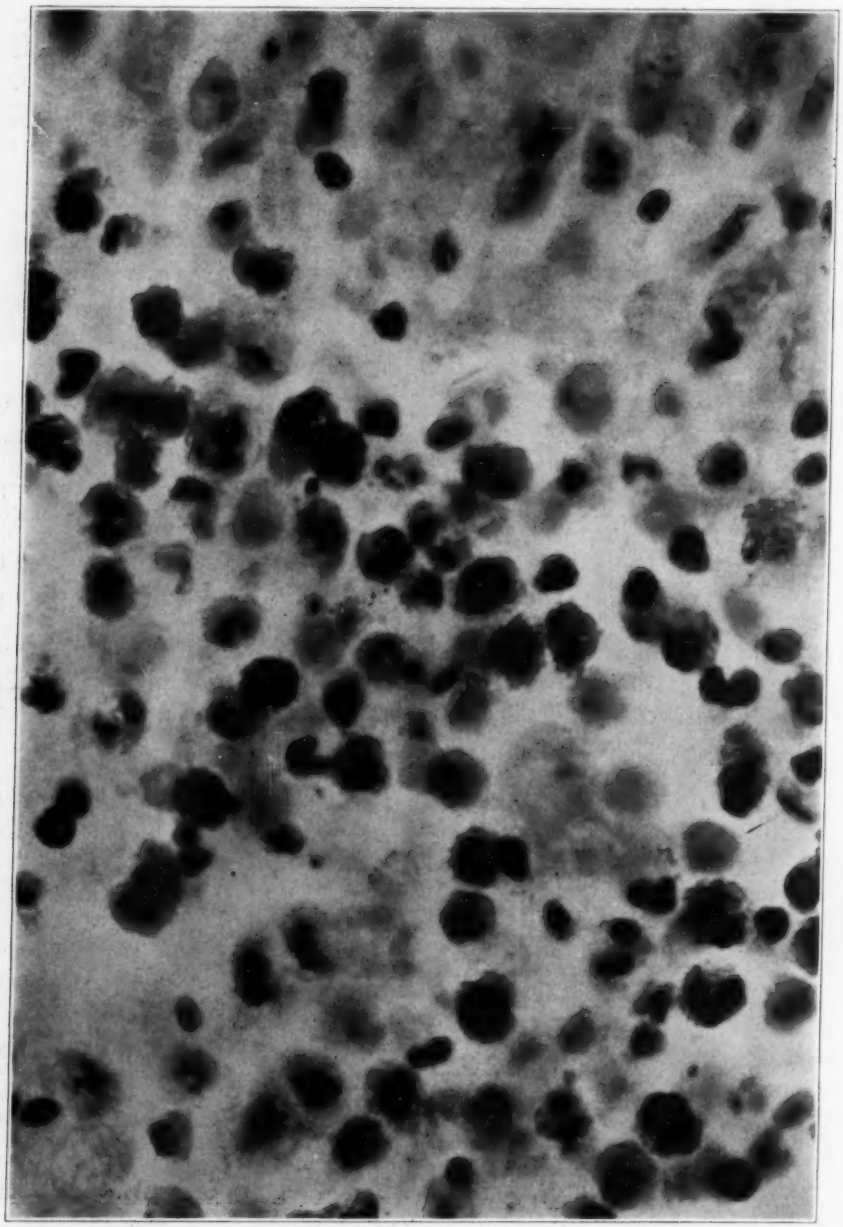

FIG. 6-E

E. T. Photomicrograph (×500) of gingival tissue removed at the onset of symptoms, when the patient was two and one-half years of age. Note the granulomatous process with large numbers of eosinophiles and pale lipid-laden macrophages. The process closely resembles the lesions of bone illustrated in Figures 1-J and 5-C. (Hematoxylin and eosin stains.)

first few patients examined in this Hospital. The reaction of the bone marrow to the destructive process may be so striking as to suggest a tumor of the blood-forming tissues.

The similarity of the roentgenographic and histological picture to that of Hand-Schüller-Christian disease may be illustrated by consideration of one of the patients, who has been observed with typical Hand-Schüller-Christian disease. This case was originally described twelve years ago in a paper by Sosman (Case II)[8], and has since been observed.

E. T., male, aged two and one-half years, was admitted to The Children's Hospital on September 25, 1928, with a complaint of polydipsia and polyuria, stomatitis, and loss of weight of six months' duration. Marked exophthalmos later developed. The clinical picture was typical of Hand-Schüller-Christian disease, and the laboratory findings were consistent with this diagnosis. X-rays showed multiple destructive lesions involving the skull, mandible, and ilium (Figs. 6-A and 6-B). (These lesions were indistinguishable roentgenographically from those characteristic of the disease under discussion.)

Histological examination was made of a cervical lymph node and of gingival tissue which surrounded a loose molar tooth (Fig. 6-E). In both specimens the predominant reaction was a granulomatous one, characterized by the presence of large numbers of eosinophiles and numerous pale lipid-laden cells. The lesions involving the skeleton healed after roentgen radiation, with new lesions appearing simultaneously in other areas, just as in certain cases of this series.

At a follow-up examination eleven years after the onset of the symptoms, the patient was a blind, feeble-minded dwarf, who exhibited marked spasticity. Roentgenographic examination at this time showed that all defects of the skeleton had healed except for a few small areas in the skull which had remained unchanged since the last examination one year before, and were apparently residual defects in ossification.

This patient had the classic symptomatology of Hand-Schüller-Christian disease, yet roentgenographically the lesions were similar to those of the cases in this series. With allowance made for the anatomical differences in the tissues, which were the site of the lesions, the process in this patient appeared to be identical in histological appearance to the destructive lesions of bone described under the term "eosinophilic granuloma" of bone.

The data upon which Farber bases his conclusions, that this disease is but a variant of the basic process of which Letterer-Siwe disease and Hand-Schüller-Christian disease are other examples, are presented elsewhere.[2] Since the etiology of the process is unknown, there is no rational basis for a name to apply to the disease. In the records of these cases, for convenience, the process has been designated by the term "destructive granuloma of bone", "single" or "multiple" as the case may be, adding parenthetically, "Hand-Schüller-Christian syndrome".

SUMMARY

1. Ten cases of benign destructive lesions of bone, either single or multiple, which appear to be identical with what has been described in the recent literature as "eosinophilic or solitary granuloma of bone", are presented. All were in children under twelve years of age.

2. Roentgenographically, single lesions simulated bone cyst, osteomyelitis, or malignancy. Multiple lesions suggested multiple myeloma

or malignancy, but in the roentgenograms were indistinguishable from Hand-Schüller-Christian disease.

3. There was little general illness associated with the disease in most instances. The symptoms were attributable mainly to the local process.

4. The histopathology presented variations from "eosinophilic granuloma" to "lipogranuloma", which is interpreted as identical with certain stages of Hand-Schüller-Christian disease.

5. Ordinarily, the lesions have healed quite promptly after roentgen radiation, and, on occasion, after curettage.

6. Nine of the ten patients were well on a follow-up examination three to ten years after they were first observed. One had died, the details of which case are unknown.

7. As suggested by one of the authors in a previous communication, eosinophilic or solitary granuloma is not a distinct new entity, but a variant of the basic process of which the clinical pictures known as Hand-Schüller-Christian and Letterer-Siwe diseases are other examples.

8. Despite the excellent prognosis in nine of the ten patients in this group, in which the recognized lesions were restricted to bone, if the suggested relationship to Hand-Schüller-Christian disease exists, the prognosis given in an individual case should be guarded, and the possibility of visceral lesions should be kept in mind.

Thanks are expressed to William E. Ladd, M.D., Chief of the Surgical Service of The Children's Hospital, for transferring to one of the authors (W. T. G.) certain patients in this group who were originally admitted to his service; and to Allan M. Butler, M.D., for the chemical determinations cited in this paper.

REFERENCES

1. Abt, A. F., and Deneholz, E. J.: Letterer-Siwe's Disease. Splenohepatomegaly Associated with Widespread Hyperplasia of Nonlipoid-Storing Macrophages; Discussion of the So-Called Reticulo-Endothelioses. Am. J. Diseases. Child., LI, 499, 1936.
2. Farber, Sidney: The Nature of "Solitary or Eosinophilic Granuloma" of Bone. Am. J. Pathol., XVII, 625, 1941.
3. Farber, S.; Green, W. T.; and McDermott, L. J.: A Recently Defined Destructive Lesion of Bone. (Report of Meeting of Boston Orthopedic Club of Jan. 20, 1941.) New England J. Med., CCXXIV, 832, 1941.
4. Lane, C. W., and Smith, M. G.: (LXXXIV.) Cutaneous Manifestations of Chronic (Idiopathic) Lipoidosis (Hand-Schüller-Christian Disease). Report of Four Cases, Including Autopsy Observations. Arch. Dermat. and Syph., XXXIX, 617, 1939.
5. Lichtenstein, Louis, and Jaffe, H. L.: Eosinophilic Granuloma of Bone. With Report of a Case. Am. J. Pathol., XVI, 595, 1940.
6. Otani, Sadao, and Ehrlich, J. C.: Solitary Granuloma of Bone. Simulating Primary Neoplasm. Am. J. Pathol., XVI, 479, 1940.
7. Schairer, E.: Ueber eine eigenartige Erkrankung des kindlichen Schädels (Osteomyelitis mit eosinophiler Reaktion). Zentralbl. f. Allg. Path. u. Path. Anat., LXXI, 113, Nov. 1938.
8. Sosman, M. C.: Xanthomatosis (Schüller's Disease; Christian's Syndrome). A Report of Three Cases Treated with Roentgen Rays. Am. J. Roentgenol., XXIII, 581, 1930.

THE PATHOLOGY OF TUBERCULOSIS OF THE SPINE *

BY MATHER CLEVELAND, M.D., AND DAVID M. BOSWORTH, M.D.,
NEW YORK, N. Y.

For the past six years the authors have been investigating all available material to determine, if possible, the localization, type, and method of invasion of tuberculosis of the adult human spine. We had been taught to believe that the lesion began in the intervertebral disc. When studies of gross and microscopic sections obtained at autopsy were begun, this idea could not be verified. Certain salient facts regarding the vertebral column or spine must be given due weight. The main intervertebral joints are of the amphiarthrodial type designated as symphysis. The only diarthrodial joints are the small intervertebral articulations situated posteriorly. The amphiarthrodial joint consists of a large intervertebral fibrocartilaginous disc, with vertical fibers closely adherent to the adjacent bone above and below, surrounded on its outer margins by perichondrium. This type of joint has no capsule or synovial lining. Lewis and Stöhr state, "Fibrocartilage in its early development, as seen in the intervertebral disc of an embryo, is primarily fibrous. It is composed of anastomosing bundles of fibers which blend with the matrix of the adjacent vertebral cartilage. Around every cartilage in the adult there is a connective-tissue envelope of perichondrium. Since perichondrium is the formative layer, a more or less perfect regeneration of cartilage may occur after surgical operation if the perichondrium is left in place. The perichondrium contains vessels and nerves, none of which penetrate the matrix of the cartilage."

Since the main intervertebral joint is not diarthrodial, is without a capsule or synovial lining, and has no blood vessels, the ordinary method of implantation of tubercle infection, as an embolic process, cannot apply to the intervertebral disc. The lesion must, therefore, begin in the bone or in the surrounding soft tissue which has an adequate blood supply. The disease may begin in the diarthrodial joints posteriorly, but this is not so frequently seen.

With these facts in mind, the authors have examined numerous specimens of the human spine which have been invaded by tuberculosis, and there have been found two constantly recurring gross pathological states in the bone,—namely, (1) caseation, and (2) sclerosis. At times a combination of these two conditions is seen.

CASEATION

Caseation, a destructive or lytic phenomenon, has been noted, beginning in the bone, the surrounding soft tissue, and the perichondrium.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 13, 1942.

It has not been noted in any instance in the intervertebral disc until massive destruction has occurred in the adjacent bone or soft tissues, and when this happens the remnant of the intervertebral disc is usually seen as a coagulated slough, not as a caseous mass.

SCLEROSIS

Sclerosis of the vertebral body has been seen with great frequency. It is difficult to reconcile this finding with tuberculosis, which is a lytic lesion. The authors have, therefore, concluded that this phenomenon of sclerosis is due to a massive loss of blood supply, and is caused indirectly by the disease. The following findings are presented to support the contention that sclerosis of bone found in tuberculosis of the spine is due to interference with the vascular supply.

1. Sclerosis of the vertebral body is seen grossly with a typical pattern of infarction extending away from an area where the blood supply has been removed from the vertebral body.

2. Sclerosis of the vertebral body is not seen unless there has been a massive dissecting abscess which strips the soft tissues and blood supply from the bone, or an obliterating vascular process,—such as thrombosis or endarteritis. The mere presence of a massive abscess in contact with bone will not explain these sclerotic changes. For instance, the radial head completely surrounded by the tubercular debris of a massively destroyed elbow joint remains intact, because its blood supply, which comes upward through the radial shaft, cannot be interrupted by pressure, thrombosis, vascular obliteration, or soft-tissue stripping.

3. That sclerosis of the vertebral body is essentially an aseptic necrosis due to loss of blood supply, is emphasized by a study of the microscopic pathology of these lesions. A microscopic section from a sclerotic area in a vertebral body adjacent to new blood supply will show bone production; a similar section in an area remote from any possible new blood supply will show little or no evidence of regenerative bone change.

4. Further microscopic study of sclerotic vertebral bodies shows areas of necrosis which are coagulative, due to ischaemia. When the phenomenon of sclerosis is encountered alone, there is no caseation.

While these two gross findings in the bone are frequently seen in combination, caseation or sclerosis may be found alone. When caseation only is found, it is a relatively early process. Where massive destruction has taken place, sclerosis will also be present, because invariably there will ensue vascular changes, such as thrombosis and endarteritis, which will affect the vertebral bodies.

The authors' study of the pathology of tuberculosis of the human spine has been revealing in many ways. Specimens have been seen with dissecting abscesses extending throughout the entire thoracic and lumbar spine, stripping the soft tissues and blood suply from the anterolateral margins of the vertebral bodies, while the posterior surfaces were uninvolved. The vertebral bodies show multiple sclerotic areas due to inter-

FIG. 1-A

FIG. 1-B

S indicates site from which soft tissue was removed for microscopic study; *B* marks the place where bone was removed for microscopic study. (This applies to other gross specimens also.)

ference with blood supply. In other instances complete sclerosis of vertebral bodies has been seen, which must have been present for several years, without collapse of the vertebrae. It is possible that collapse failed to occur because these vertebral bodies were extremely hard, and their ischaemic state rendered them invulnerable to attack by the bacterial and toxic processes.

These sclerotic lesions of tuberculosis of the spine have been frequently observed to progress very slowly, whereas the lytic lesions, where there has not been much loss of blood supply to the vertebral bodies and the disease is free to act unhampered, may progress rapidly with marked destruction and resulting kyphosis.

The frequent aspiration of an abscess due to tuberculosis of the vertebrae will do much to prevent further stripping of the soft tissue from the vertebral bodies: thus further ischaemic necrosis may be minimized.

The roentgenogram of the spine has its limitations, and it frequently fails to reveal the presence or the extent of invasion by tuberculosis. The authors have searched in vain for roentgenographic evidence of tuberculosis in many spines which have been massively invaded, and where post-

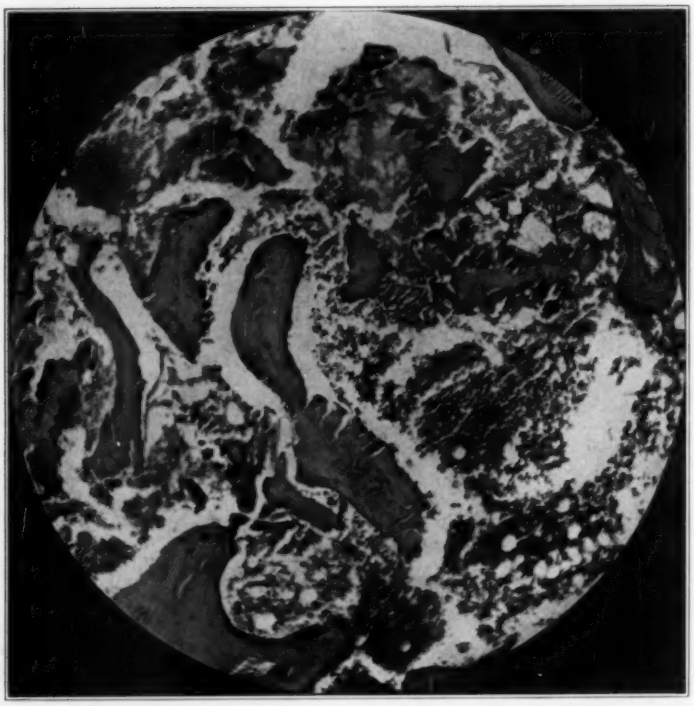

FIG. 1-D

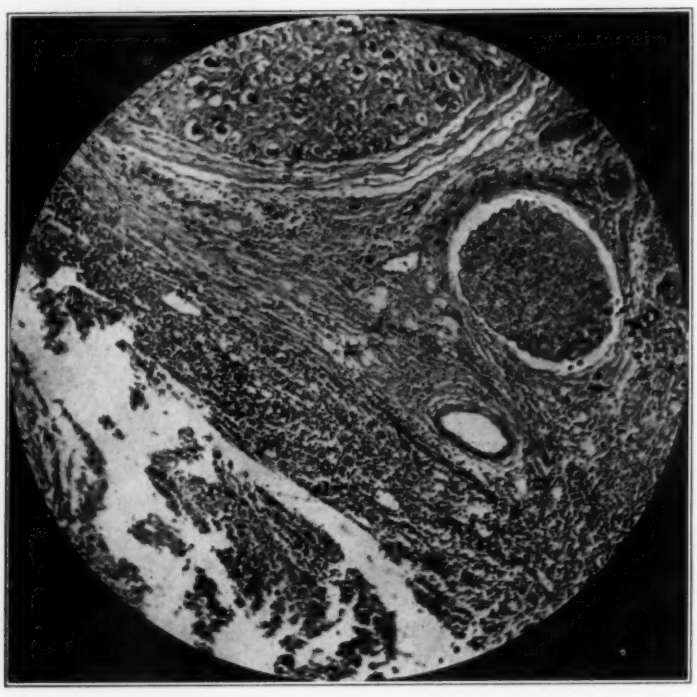

FIG. 1-C

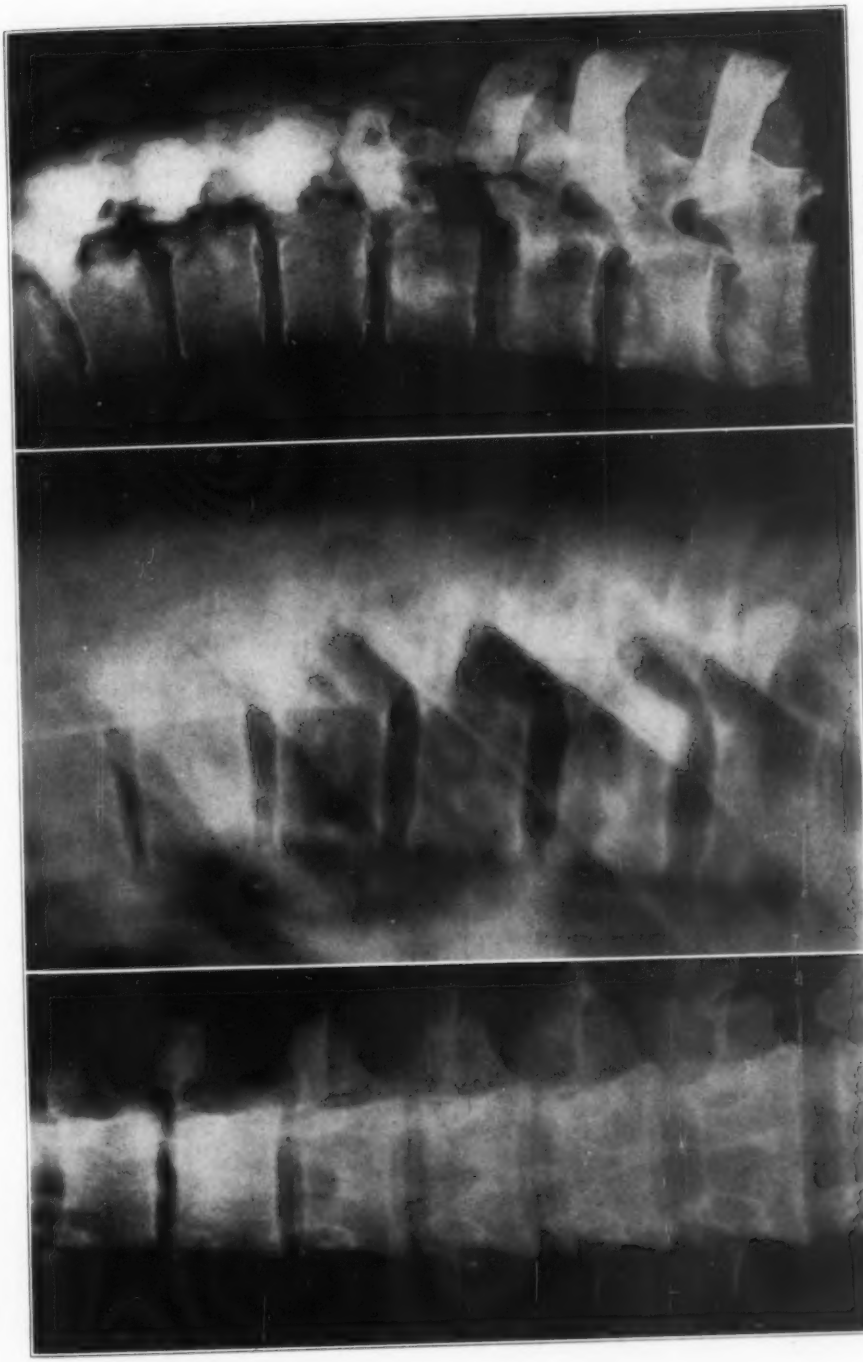

FIG. 1-G

FIG. 1-F

FIG. 1-E

mortem examination has yielded abundant evidence of the disease. There are certain roentgenographic findings previously overlooked which are now recognized—such as sclerosis or mottling of the vertebral bodies in a known tuberculous patient—which lead to an earlier diagnosis of the disease than was formerly possible.

Fusion of the spine is purely a mechanical aid. It may arrest damage until the new productive changes, which are frequently associated with sclerosis due to ischaemia, are able to heal the defect. If there are no areas of living bone to act as centers for creeping replacement, healing may be prolonged indefinitely or may fail to occur. Under these latter circumstances technically adequate fusion may fail to arrest the disease.

The accompanying gross, microscopic, and roentgenographic studies of specimens of the human spine are submitted in support of these conclusions. (See legend for Figures 1-A and 1-B.)

Specimen No. 25.

B. M. (Sea View Hospital No. 15434). The gross specimen (Figs. 1-A and 1-B), which has been split to show a hemisection of the vertebrae from the medial and lateral aspects, shows an invasion of numerous vertebral bodies by exudative granulation tissue, and small abscesses of the soft tissues on the lateral surface around the ribs, but no massive dissec-

FIG. 2-A

FIG. 2-B

tion of the vertebral bodies except posteriorly in two areas. The process is essentially a caseous or destructive tuberculous lesion, primarily in the bone, but with secondary abscess formation in the soft tissue.

The photomicrograph of the soft tissue (Fig. 1-C) shows the wall of an abscess cavity with round-cell inflammatory reaction extending into the surrounding fibrous tissue. A blood vessel, nerve trunk, and spinal ganglion are seen.

The photomicrograph of the bone (Fig. 1-D) shows a destructive lesion of bone with degeneration, fragmentation, and inflammatory round-cell infiltration, a picture of bone necrosis and liquefaction typical of a caseous or destructive type of lesion.

The roentgenograms, anteroposterior and lateral (Figs. 1-E and 1-F), taken before death, fail to reveal any evidence of the disease in spite of its great extent. The intervertebral spaces are wide. The roentgenogram of the washed specimen (Fig. 1-G) still shows very little definite evidence of disease in the vertebral bodies except for slight mottling.

Specimen No. 12.

H. H. (Sea View Hospital No. 11935). The gross specimen split longitudinally (Figs. 2-A and 2-B), shows the lateral aspect of the vertebrae and the interior of the vertebral bodies. There is marked sclerosis, of the wedge-shaped type, of three vertebral bodies which indicates a loss of blood supply. The cause of this infarction is a stripping of the soft tissue from the bone. The central intervertebral disc shows a sloughing of its nucleus, because the perichondrium has lost its blood supply. The posterior elements—that is, the pedicles and articular facets—have been grossly invaded. In this instance it is quite likely that the disease began in the posterior elements, and the sclerosis of the first and third vertebral bodies from above downward was caused by dissection of the covering soft tissue, thrombosis, and endarteritis extending from behind forward.

The photomicrograph of the soft tissue (Fig. 2-C) shows massive caseous necrosis and debris, with granulation tissue and round-cell infiltration. There is seen a nerve trunk surrounded by collagenous fibrous tissue.

The photomicrograph of bone (Fig. 2-D) shows necrosis and degeneration of bone, with fragmentation. The necrotic area is covered with new bone formation, which probably represents repair. The interstices between bone structures show coagulative necrosis. This section was taken from an area where new blood supply was available. This specimen is typical of sclerosis due to loss of blood supply.

The anteroposterior and lateral roentgenograms of this area of the spine (Figs. 2-E and 2-F), taken before death, show a slight thinning of the joint space between two vertebrae, and a suggestion of sclerosis of the vertebral body below the thin intervertebral space.

The roentgenogram of the split and washed specimen (Fig. 2-G) shows the thin joint space and very evident sclerosis of the vertebral body below this space, and some sclerosis of the two vertebral bodies above.

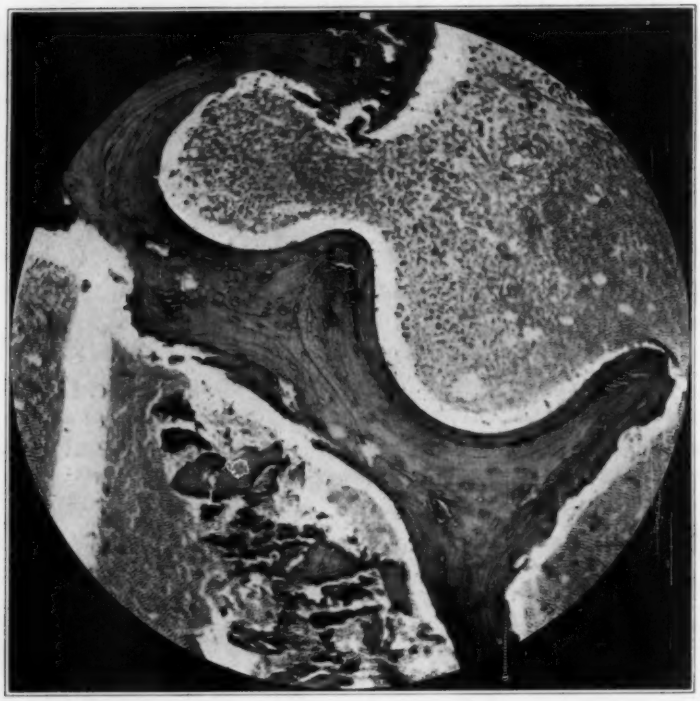

FIG. 2-D

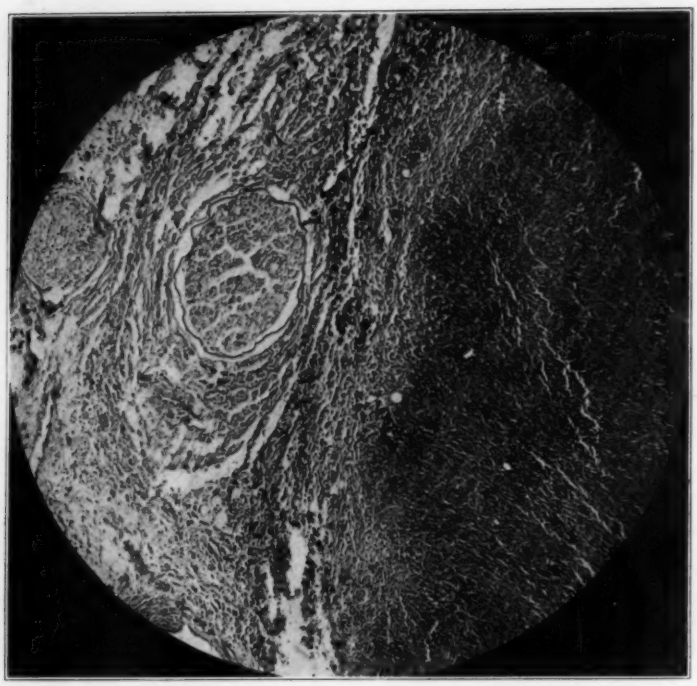

FIG. 2-C

FIG. 2 G

FIG. 2-F

FIG. 2-E

Specimen No. 14.

J. B. (Sea View Hospital No. 11467). The gross specimen (Fig. 3-A) shows a longitudinal hemisection of two vertebral bodies viewed from the split surface. The upper vertebral body shows dense sclerosis at the lower anterior quarter, due to a loss of blood supply. The sclerosis follows a pattern occasioned by the stripping of soft tissues and their blood vessels away from the bone. This same vertebral body shows some sclerosis at its posterior margin, where the soft tissue and periosteum have been raised by an abscess. This specimen shows an early sclerotic lesion.

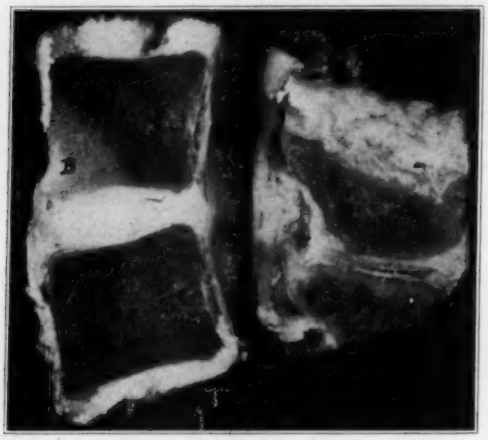

FIG. 3-A

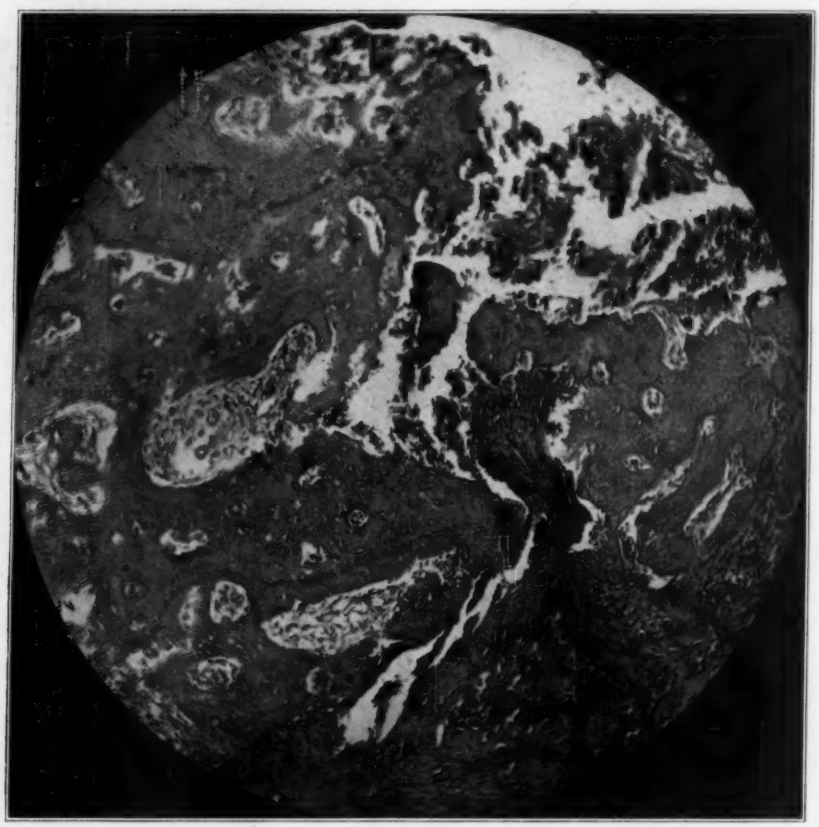

FIG. 3-B

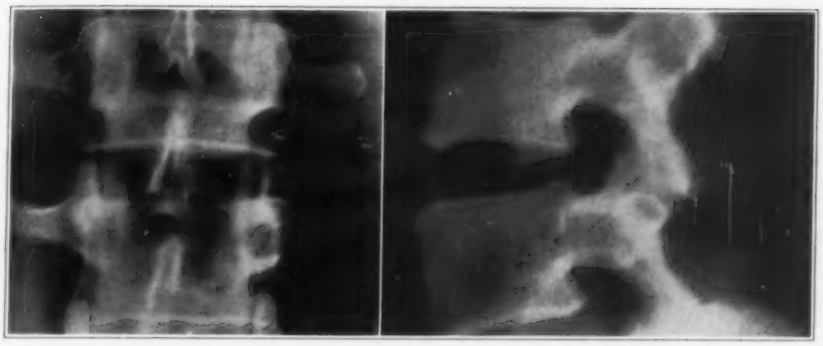

FIG. 3-C

FIG. 3-D

The photomicrograph of bone taken from the large sclerotic area (Fig. 3-B) shows marked necrosis of bone, with increased calcification and little or no fragmentation. This is the appearance of aseptic necrosis of bone, rather than of inflammatory change,—a sclerosing process.

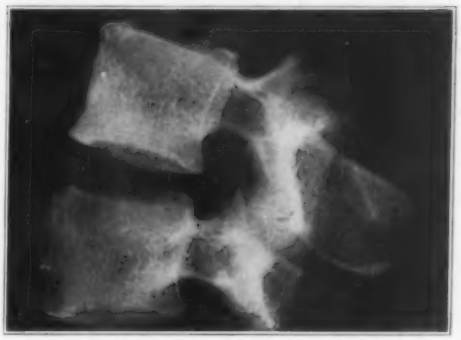

FIG. 3-E

The anteroposterior and lateral roentgenograms of the two vertebrae taken while the patient was alive (Figs. 3-C and 3-D) show no evidence of pathology in the vertebrae or intervertebral disc.

The roentgenogram of the washed specimen (Fig. 3-E) shows very definite sclerosis of the anterior inferior portion of the upper vertebra.

Specimen No. 15.

A. G. (Sea View Hospital No. 8351). The gross specimen (Fig. 4-A) shows three and a half vertebrae split longitudinally. There is a typical dissecting abscess anterior to two vertebral bodies and the intervening intervertebral disc. Both vertebrae show destructive changes due to infection, and sclerotic changes due to the loss of blood supply. The intervertebral disc is in part destroyed, having formed a portion of the abscess which invaded it from the soft tissues and perichondrium at the front.

The photomicrograph of the soft tissue (Fig. 4-B) shows the fibrous-tissue wall of the abscess, with round-cell infiltration, a giant cell, and caseous necrotic material.

The photomicrograph of bone (Fig. 4-C) shows sclerosis of bone, round-cell infiltration, and necrosis of bone. This lesion represents a composite picture of changes due to destructive infection, caseation, and sclerosis caused by a loss of blood supply.

FIG. 4-B

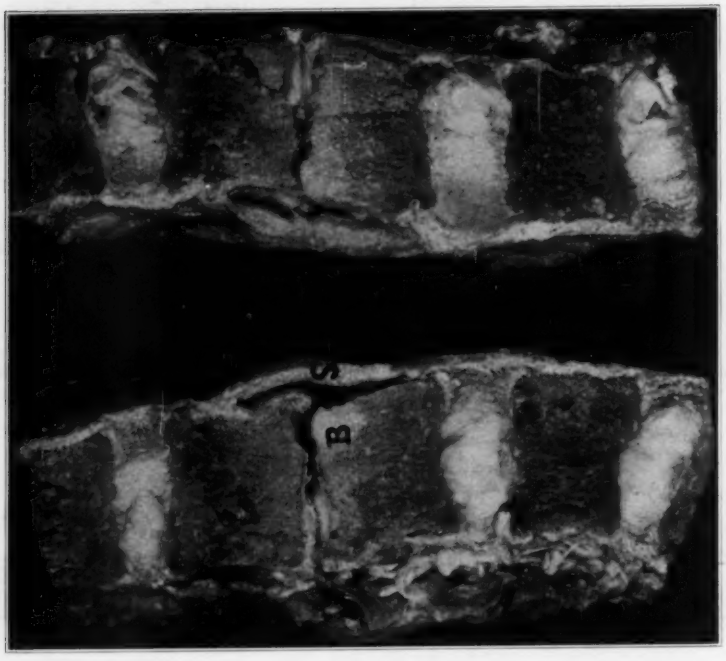

FIG. 4-A

FIG. 4-D

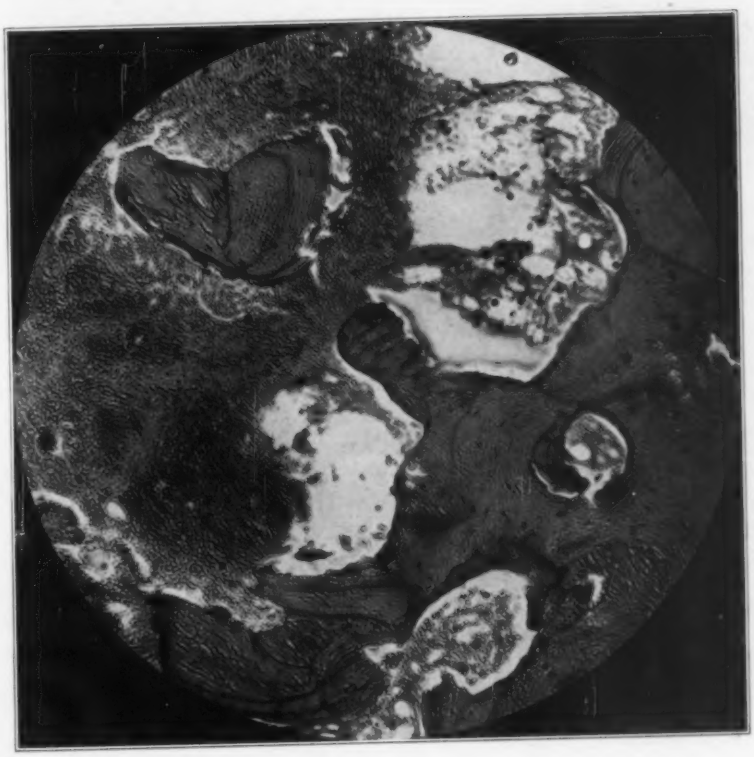

FIG. 4-C

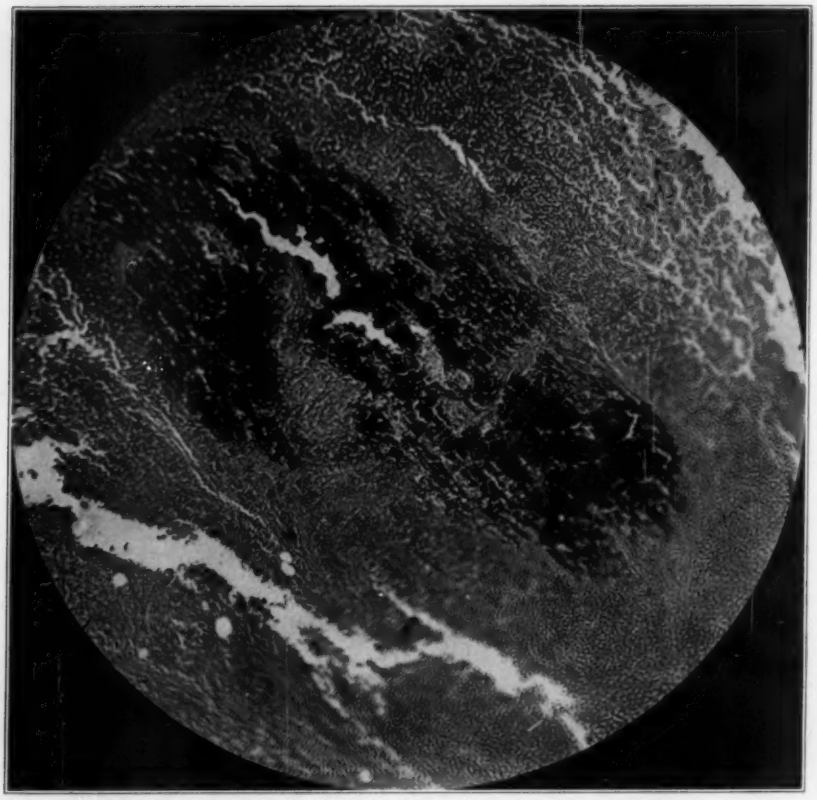

FIG. 5-B

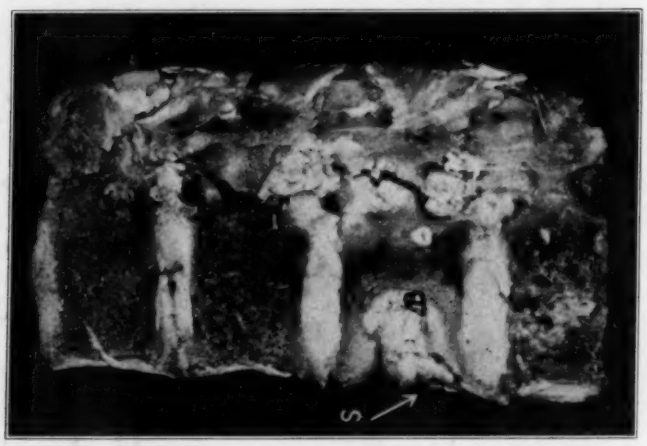

FIG. 5-A

The roentgenograms of the washed specimen (Fig. 4-D) show beyond question destructive and sclerotic changes in the two vertebrae and the intervening disc.

Specimen No. 10.

R. S. (Sea View Hospital No. 2797). The gross specimen (Fig. 5-A) shows a longitudinal hemisection of three and one-half vertebral bodies and the intervertebral discs. There is caseous involvement of a vertebral body, which is probably secondary to a lesion in the soft tissues on the anterior border of that body. Surrounding this zone of caseation, there is an area of sclerosis due to loss of blood supply resulting from the abscess surrounding the vertebral body and also from the large abscess within the body. Sclerosis of the posterior aspect of the vertebral body should be noted. The vertebral body below also shows an advanced caseous lesion.

The photomicrograph of the soft tissue (Fig. 5-B) shows caseous necrotic debris with secondary calcium deposit,—a calcified abscess.

The photomicrograph of the bone (Fig. 5-C), which was taken adjacent to the caseous area, shows degenerating and fragmenting bone,

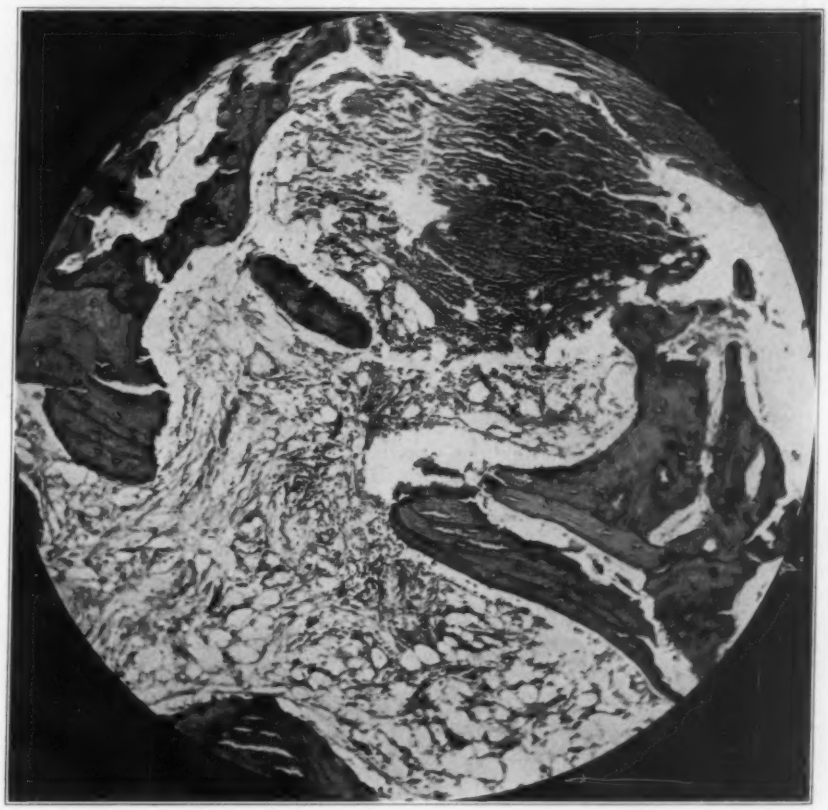

FIG. 5-C

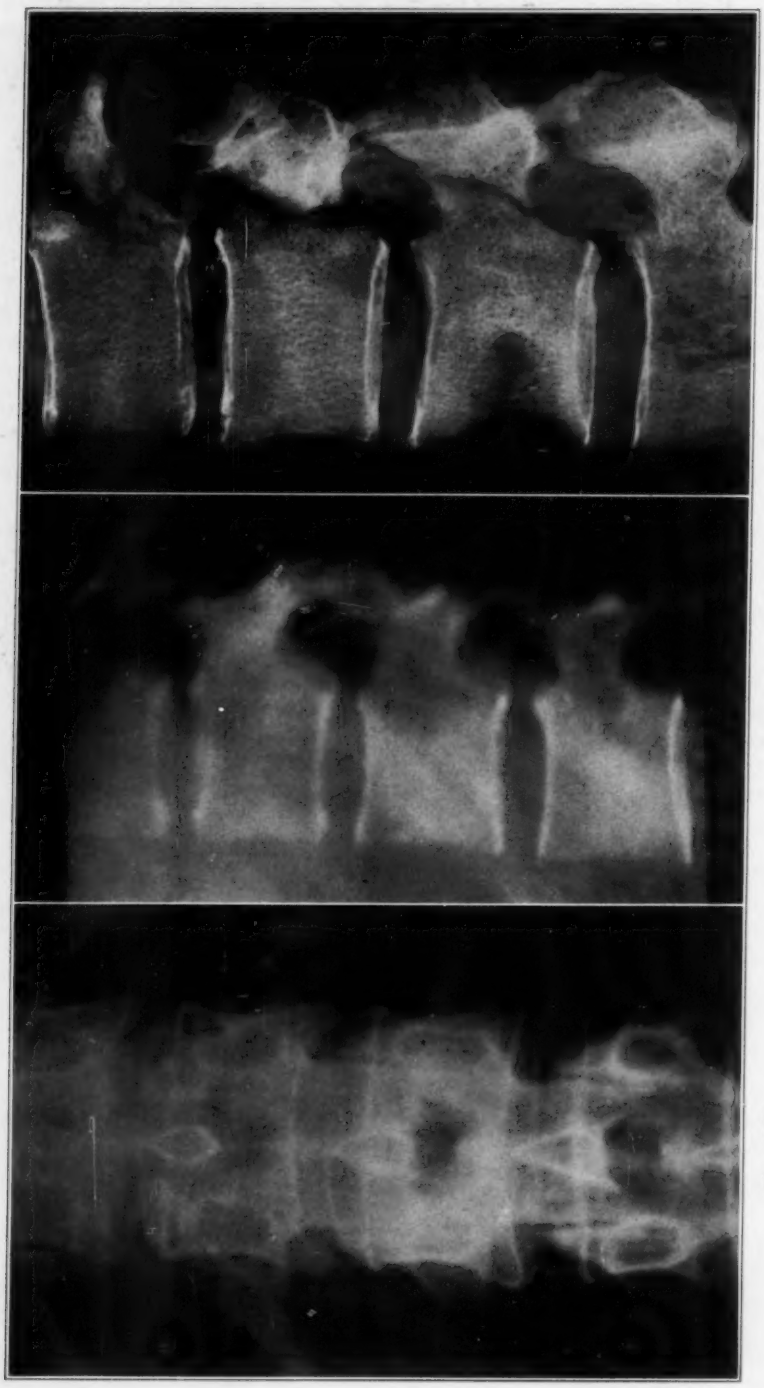

FIG. 5-F

FIG. 5-E

FIG. 5-D

with granulation tissue and necrosis in the marrow. This specimen shows a combination of both caseation and sclerosis.

The roentgenograms taken before death (Figs. 5-D and 5-E) show wide intervertebral spaces and no abscess shadow. On very careful scrutiny slight decalcification and sclerosis may be noted in the intermediate vertebral body, the first lumbar vertebra, and perhaps in the second lumbar. This escaped notice in the living patient.

FIG. 6-A

The roentgenogram of the split and washed specimen (Fig. 5-F) shows the marked erosion or destruction of the bodies of the first and second lumbar vertebrae, with some increased density of the first lumbar.

Specimen No. 23.

J. S. (Sea View Hospital No. 11322). The gross specimen (Fig. 6-A) shows a longitudinal hemisection of parts of eight vertebrae from the lower thoracic and lumbar spine. Multiple sclerotic areas may be noted in several vertebral bodies with destructive changes and abscesses; the abscesses have surrounded some of the vertebral bodies depriving them of their blood supply. The picture is complicated by a spine fusion extending over the upper four full vertebrae. This was an inadequate fusion because at the time it was done the extent of the disease could not be determined by roentgenogram. The fusion has stabilized these vertebrae and has been responsible for the partial arrest of the disease in some of these bodies. It is, however, acting as a lever to further compress the unprotected and diseased area of the spine below. The sclerotic and productive bone changes are tending to obliterate the gap left by the disc which has sloughed between the third and fourth vertebrae from above downward. These changes have already caused the union of the remnant of the fifth body to the fourth.

One photomicrograph of the soft tissue (Fig. 6-B) shows a large vessel

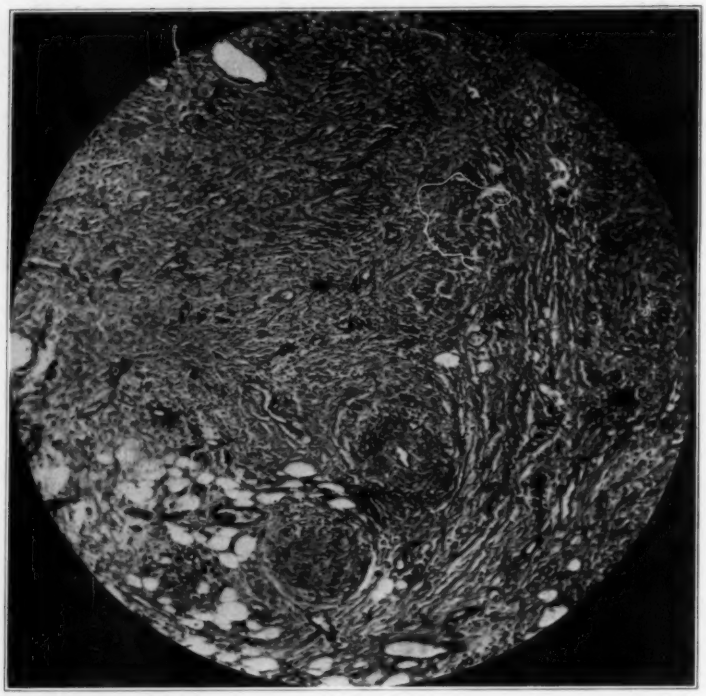

FIG. 6-C

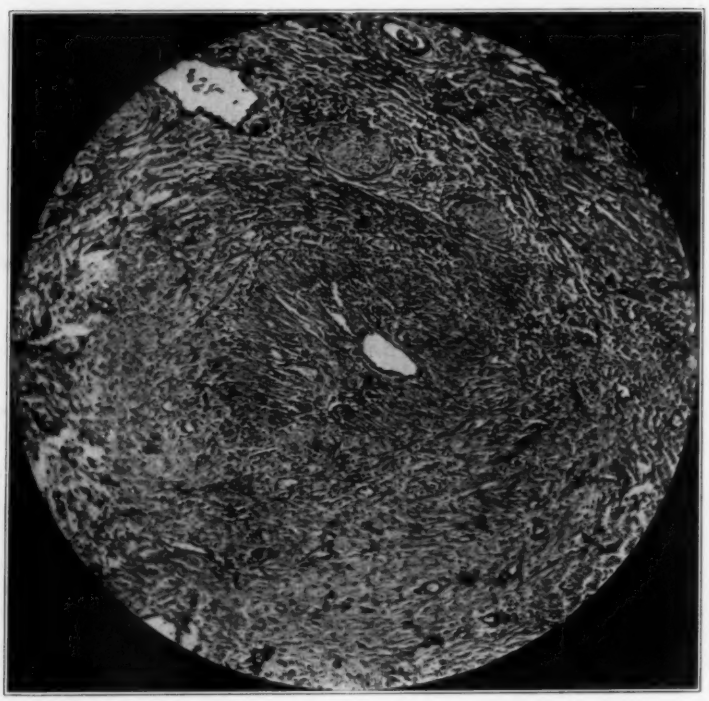

FIG. 6-B

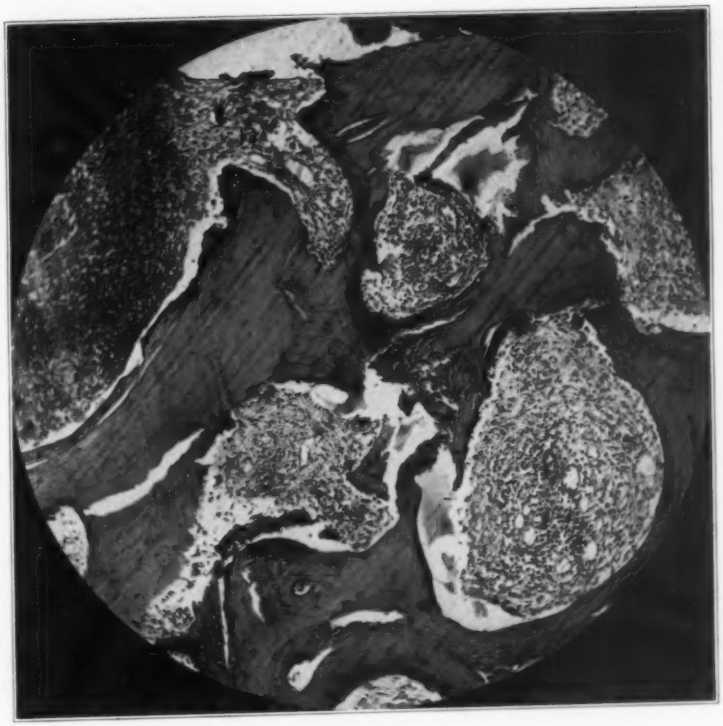

FIG. 6-D

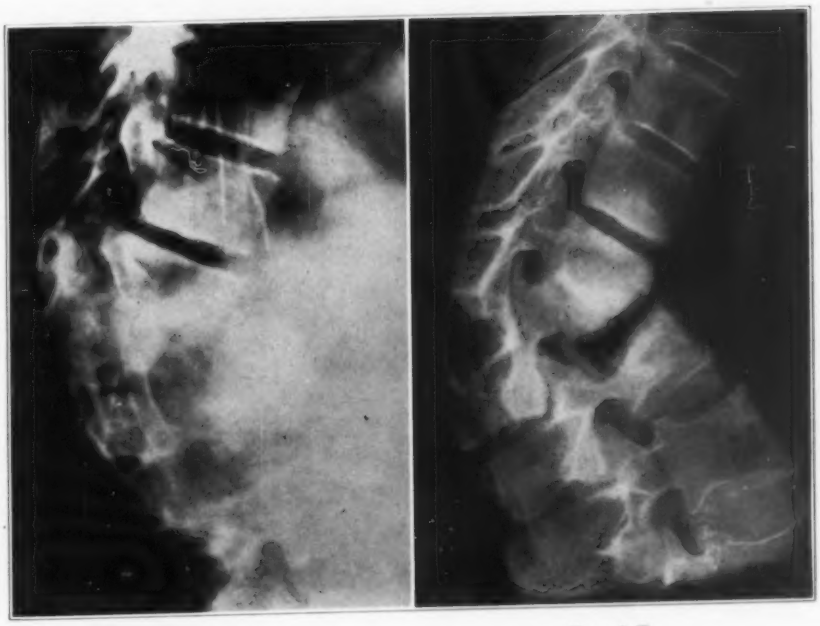

FIG. 6-E

FIG. 6-F

which has been thrombosed, recanalized, thrombosed again, and once more recanalized. In another area (Fig. 6-C) there are two smaller vessels (eight and nine o'clock positions), one of which has been completely obliterated by endarteritis; the other vessel still shows a small lumen but with marked endarteritis.

The photomicrograph of bone (Fig. 6-D) shows granular necrosis with inflammatory changes and some old-bone formation. The appearance is more that of aseptic necrosis due to loss of blood supply, than of inflammatory change.

The lateral roentgenogram taken during life (Fig. 6-E) shows a marked destructive and sclerotic lesion involving three vertebrae, with a thin joint space above those vertebrae. This is a typical roentgenogram of an advanced lesion of the spine due to tuberculosis.

The lateral roentgenogram of the washed specimen (Fig. 6-F) shows the same condition with the sclerotic and destructive changes accentuated. The extent of the spine fusion can be readily seen.

SUMMARY

1. Two pathological processes have been encountered in the human spine due to tuberculosis: first, caseation of bone and soft tissue—a destructive lesion due directly to the infection—and, second, sclerosis of bone, which, it is believed, is a vascular phenomenon occasioned by loss of blood supply from thrombosis or endarteritis, or occlusion or destruction of blood vessels by the presence of large dissecting abscesses.

2. The roentgenogram will often fail to reveal the presence of tuberculosis of the spine, and will never reveal the full extent of the damage due to the disease.

REFERENCES

Bosworth, D. M.: Tuberculosis of the Osseous System. Part I. Tuberculosis Involving the Spine. Quart. Bull. Sea View Hosp., V, 85, 1939.

Bosworth, D. M., and Haines, Keith: Results of Spine Fusions; Critical Review of Several Surgical Techniques. Quart. Bull. Sea View Hosp., VI, 176, 1941.

Cleveland, Mather: Tuberculosis of the Spine. A Clinical Study of 203 Patients from Sea View and St. Luke's Hospital. Am. Rev. Tuberc., XLI, 215, 1940.

Treatment of Tuberculosis of the Spine. J. Bone and Joint Surg., XXII, 824, July 1940.

Lewis, F. T., and Stöhr, P.: A Text-Book of Histology Arranged upon an Embryological Basis. Ed. 2. (Being the 7th American Edition of Stöhr's Histology, from the 15th German Edition, Edited by O. Schultze.) Philadelphia, P. Blakiston's Son and Co., 1913.

ORTHOPAEDIC TREATMENT OF HYPERTROPHIC ARTHRITIS OF THE HIP *

BY JOHN G. KUHNS, M.D., BOSTON, MASSACHUSETTS

From the Robert Breck Brigham Hospital, Boston

This paper is a study of 183 patients—eighty-six men and ninety-seven women—who were treated on the wards of the Robert Breck Brigham Hospital, before January 1941, for disabilities resulting from hypertrophic arthritis of the hip joint. In 114 patients both hips were involved and in sixty-nine one hip only was involved. The average age of the entire group at admission was 52.7 years. The age distribution was about the same for patients with both unilateral and bilateral involvement of the hip (Table I). This study of the results of conservative treatment was prompted by the infrequent mention of non-surgical treatment of this

TABLE I

AGE DISTRIBUTION OF 183 PATIENTS

(In Years)

No. of Hips	31–35	36–40	41–45	46–50	51–55	56–60	61–65	66–70	71–75	76–80
One.....	1	2	7	10	11	12	18	4	2	2
Two.....		5	5	6	18	24	26	21	6	3
Totals	1	7	12	16	29	36	44	25	8	5

condition in medical literature during the past ten years. From the published reports one would be led to believe that surgery was the only effective therapy for this disability.

The causes of hypertrophic arthritis are not clearly understood, but all investigators of this problem are agreed that it is partially an ageing or wearing out of joints [1]. In addition to this senescence of the joints, there have been postulated other factors—mechanical [1], biochemical [2], and circulatory [3]—which lead to more rapid changes within the joint. It has been observed that the articular changes progress more rapidly when strain and stress come upon the joint in an excessive amount or in an abnormal position of use.

With this imperfect knowledge of the etiology of hypertrophic arthritis, attempts at treatment must of necessity be directed chiefly against those physical factors which are known to lead to more rapid progression

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons at Atlantic City, New Jersey, January 15, 1942.

FIG. 1

Roentgenogram of patient with early hypertrophic arthritis of the hip. There is increased forward inclination of the pelvis and weight is borne upon the posterior aspect of the acetabulum and the anterior surface of the femoral head.

of the disturbance. Strains can be treated by rest, by protection of the joint, and by changing weight stresses through realignment of the whole body. Obesity can frequently be lessened by proper dietary measures. A change of occupation to less strenuous work is occasionally indicated [5]. Anatomical malformations about the hip joint can be modified only by surgical intervention, but their effects upon the body can frequently be lessened by the development of correct body mechanics.

At the hip joint, the weight of the body is borne normally by the central portion of the femoral head in contact with the strong and superior portion of the acetabulum. Whenever this is not the position of use, either from anatomical changes in the femoral head and acetabulum, or from an increased forward inclination of the pelvis accompanying faulty body mechanics, a disalignment results in the articular surfaces, and there is an impairment of muscle action [4]. This is followed by articular irritation and by strain of muscles and ligaments (Fig. 1).

Muscle action becomes less efficient both for locomotion and for the stability of the hip joint, with the increased forward inclination of the pelvis which is always found in hypertrophic arthritis of the hip. After this condition has once begun, weakness develops in the musculature about the hip, particularly in the gluteus medius. Flexion of the hip is followed by adduction and by external rotation. Ligament strain occurs and is accompanied by osteocartilaginous proliferation about the hip.

An early roentgenographic diagnosis is usually not possible. The process is usually present for a number of years before symptoms appear [10]. The earliest roentgenographic change observed is an increased density in the posterosuperior margin of the acetabulum and the anterosuperior surface of the femoral head (Fig. 2). While there is always measurable limitation of motion in the hip joint when this is present, there are often

FIG. 2

Roentgenogram showing early hypertrophic arthritis of the right hip. There is increased density in the upper portion of the femoral head and the superior margin of the acetabulum.

no subjective symptoms. These early roentgenographic changes are followed by osseous proliferation around the posterior edge of the acetabulum, and about the anterior side of the femoral head and neck. Later there is deformation of the femoral head and bone proliferation at the attachments of the adductors and rotators of the hip. Hydrarthrosis, villous proliferation, and irregular growth of cartilage are not readily demonstrated in roentgenograms, although they often can produce greater disability than the evident osseous changes [7] (Fig. 3-A).

The chief symptoms for which the patients seek relief are pain and limitation of motion. The almost constant relief of pain following rest or fixation suggests that strain of the muscle attachments, the ligaments, and the articular capsule are the chief sources of pain. The limitation of motion varies in degree from slight limitation of adduction and external rotation to no appreciable motion in the hip joint. The patient's first awareness of disability may come with inability to cross the knee or to tie the shoes. In the severer forms of hypertrophic arthritis of the hip, the leg is constantly in flexion, adduction, and external rotation, and the patient has difficulty in sitting, and has a very awkward, shuffling gait.

Complete healing and restitution of anatomical contour do not occur with any known form of treatment. Since the cause of symptoms appears to be primarily a ligament or muscle strain, treatment should first relieve such strain and attempt to prevent its recurrence. This is

FIG. 3-A

Roentgenogram showing hypertrophic arthritis of the right hip with symptoms of twenty years' duration.

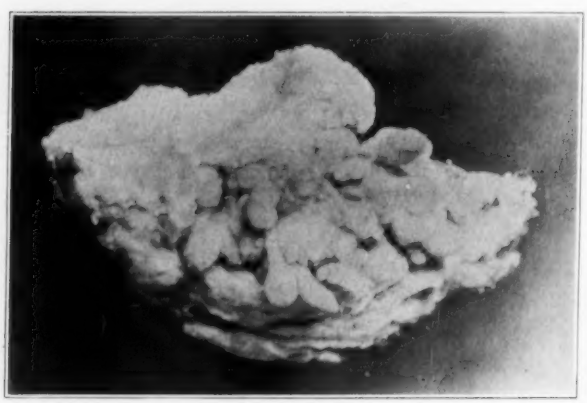

FIG. 3-B

Pathological specimen showing the anterior portion of the joint and of the articular capsule, with extreme villous formation and soft-tissue overgrowth.

accomplished by rest in recumbency, and, in the severer cases, by splinting of the hip. To secure lasting improvement in function, treatment must correct or decrease the flexion and adduction deformity of the hip. This is brought about by exercises, casts, traction, and, in rare instances, by manipulation. It must also decrease the excessive forward inclination of the pelvis and secure weight-bearing with the head of the femur in contact with the strong, superior part of the acetabulum. This is obtained by postural exercises and by the temporary wearing of a pelvic belt. The treatment which has been used by the author, with the indications for the various procedures, is given in Table II.

TABLE II
PLAN OF TREATMENT

Indications	*Treatment*
Pain and muscle spasm	Rest in bed
Continued muscle spasm and deformity	Traction (skin)
Deformity and pain	Spica
Muscle weakness and faulty weight-bearing at the hip joint	Exercises for correction of body mechanics
Incomplete correction of flexion and adduction deformity, and weakness of muscles	Pelvic belt or special corset
Limitation of motion with little change in the femoral head	Manipulation
Persisting pain, particularly in the aged	Roentgenotherapy

On admission to the Hospital the patient was placed on a firm bed. A pillow was put under the thigh if there was much muscle spasm or flexion deformity. Heat was applied over the affected hip anteriorly and laterally for periods of thirty minutes three times a day. As soon as muscle spasm had subsided, exercises were given to decrease the lordosis of the lumbar spine and the forward inclination of the pelvis, and to lessen the flexion deformity of the hip. These exercises, performed at least twice a day, taught the patient to retract the lower abdomen and at the same time to contract the gluteal muscles. In this way deformity was gradually decreased, and the weight-thrust in walking was brought more nearly upon the superior and strong part of the acetabulum rather than upon the posterior portion. Pain usually subsided within ten days.

When symptoms did not subside quickly and there was persisting flexion and adduction deformity, a spica was applied to the hip including the entire leg. When deformity was corrected very slowly, a series of plaster spicas were sometimes required, each spica securing a little more correction of the deformity. Traction upon the hip joint was employed only in the presence of much muscle spasm with little limitation of motion. When muscle spasm and pain had subsided, the patients were allowed up for increasing periods of time with a pelvic belt or corset. This was found to be an adequate support for the prevention of further symptoms, after the patient had been taught to bear weight upon the hip joint in a better functional position. In many instances normal weight-bearing at the hip joint could not be regained, but in most of the patients sufficient improvement was obtained in the position in which the hip was used. Through this improved use of the hip joint, tendency to recurrence of the deformity was less, sprain was eliminated or greatly lessened, and pain disappeared.

While this orthopaedic treatment was being carried out, an appraisal of the general state of health was made, and such factors as obesity, endocrine disturbances, and faulty hygiene were considered. This was done to aid in maintaining the improvement gained. The average stay in the Hospital for these patients was six weeks. The ability to walk without

pain and to work often required a longer period. Occasionally maximum improvement was seen only after a number of months. When no relief of symptoms was observed after several weeks of treatment, other causes of the symptoms than the hypertrophic arthritis were usually present. Chief among these other causes were malignancy, osteitis deformans, and acute infections.

The end results of treatment, a year or more after discharge from the Hospital, are given in Table III. Those listed as working and without symptoms had no pain on walking, no noticeable deformity, and were doing their regular work. Those listed as improved had less pain than before, less deformity at the hip, and an increase in motion of 10 degrees or more. Those unimproved showed little change or became worse.

Eight patients died in the Hospital, seven have since died, and ten cannot be traced at the present time. Of the fifty-three patients who were not helped by the treatment, twenty-one were elderly individuals with extensive generalized hypertrophic arthritis and with other chronic diseases. Conservative treatment was found to be least effective in young persons with extensive malformation of the femoral head and acetabulum, particularly where this condition was present on one side only. In these individuals, surgery is the preferred form of treatment.

There are two other procedures which should be considered in the conservative treatment of hypertrophic arthritis of the hip,—manipulation of the hip joint, and roentgenotherapy. Eight of the patients who were unimproved were subjected to manipulation under anaesthesia (Table IV). This procedure is advocated only when there is not much

FIG. 4-A

FIG. 4-B

Posterior and lateral views of the pelvic belt used in the treatment of hypertrophic arthritis of the hip.

TABLE III
END RESULTS OF TREATMENT BY REST, HEAT, AND EXERCISE

Age of Patients and Hips Involved	No. of Patients	No Symptoms. Working		Slight Symptoms. Improved		Unimproved		Died or Untraced
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.
Unilateral								
45 years of age or under...	10	1	10.0	3	30.0	6	60.0	0
Over 45 years of age.....	55	18	32.7	19	34.6	18	32.7	4
Bilateral								
45 years of age or under...	9	2	22.2	2	22.2	5	55.6	1
Over 45 years of age.....	84	26	30.9	34	40.5	24	28.6	20
Totals.....	158	47	29.8	58	36.7	53	33.5	25

TABLE IV
END RESULTS OF OTHER TREATMENT

Treatment	No. of Patients	Relieved		Partially Relieved		Unrelieved	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
Manipulation.....	8	7	87.5	0	0.0	1	12.5
Roentgenotherapy.....	21	16	76.2	0	0.0	5	23.8

alteration of the spherical shape of the femoral head [6]. Under such conditions the limitation of motion and the deformity are chiefly the result of muscle spasm and of contractures in the soft tissues. This limitation of motion may be improved by a gentle manipulation of the hip joint. An increased range of motion is secured by stretching contractures which have developed in the articular capsule and in the muscles, particularly the adductors. The manipulation is carried out gently, an assistant holding the pelvis; the hip is brought into acute flexion, abduction, and internal rotation. Seven of these patients were much improved by this procedure. One patient with moderate deformation of the femoral head was not benefited. The improvement in these patients has continued to the present time.

Roentgenotherapy in hypertrophic arthritis of the hip is used as a palliative measure only [9]. It does not lead to any appreciable change in

the deformity, but it frequently relieves pain, and increased motion at the hip joint is seen sometimes following its use. It is used particularly in elderly individuals with severe pain, when vigorous therapy would not be well tolerated. Roentgenotherapy has been used in twenty-one elderly persons with hypertrophic arthritis of the hip, with relief of pain in sixteen of them (Table IV).

CONCLUSIONS

The symptoms observed in the presence of hypertrophic arthritis of the hip are frequently the result of muscle and ligament strain. With the increased forward inclination of the pelvis and the flexion of the hip, weight-thrust is changed, and the function of the muscles about the hip is impaired. This leads to strain, fatigue, and instability.

The aim of orthopaedic treatment of such disability is the use of the hip in as nearly normal weight-bearing as possible. In this way recurrence or aggravation of the disability is prevented.

In 158 patients with disability from hypertrophic arthritis of the hip, forty-seven, or 29.8 per cent., were entirely relieved of their symptoms, and fifty-eight, or 36.7 per cent., were greatly improved. The least improvement was observed in those with unilateral involvement and in those with extensive flexion and adduction deformity. It is among these, particularly the latter group, that surgical therapy is sometimes required.

Manipulation of the hip often leads to improved motion, if there is little deformation of the femoral head.

Roentgenotherapy is a helpful measure to relieve pain, particularly in aged or debilitated patients.

REFERENCES

1. Cowdry, E. V. (Editor): Problems of Ageing: Biological and Medical Aspects. A Publication of the Josiah Macy, Jr., Foundation. Baltimore, Williams & Wilkins Co., 1939.
2. Fletcher, E.: Heberden Lecture. Osteoarthritis; an Attempt to Elucidate the Ætiology and Pathogenesis of the Condition by Clinical Study and Analysis. British J. Rheumatism, II, 62, 1939.
3. Kling, D. H.: The Significance of Peripheral Circulatory Disturbances for the Development of Osteo-Arthritis. Am. J. Med. Sciences, CXCVII, 358, 1939.
4. Kuhns, J. G.: Hypertrophic Arthritis of the Hip. A Review of Seventy-Nine Patients. New England J. Med., CCX, 1213, 1934.
5. Magnuson, P. B.: Arthritis and Injury—and Their Relation to Injury and Arthritis. Industrial Med., VIII, 231, 1939.
6. Mennell, James: The Science and Art of Joint Manipulation. Vol. I: The Extremities. Philadelphia, P. Blakiston's Son & Co., 1939.
7. Saxl, Alfred: Statische Gelenkentzündungen. Wiener Klin. Wchnschr., XLVIII, 76, 1935.
8. Short, C. L., and Bauer, Walter: The Treatment of Degenerative Joint Disease. New England J. Med., CCXXV, 145, 1941.
9. Smyth, C. J.; Freyberg, R. H.; and Peck, W. S.: Roentgen Therapy for Rheumatic Disease. J. Am. Med. Assn., CXVI, 1995, 1941.
10. Wiberg, G.: Studies on Dysplastic Acetabula and Congenital Subluxation of the Hip Joint with Special Reference to Complication of Osteo-Arthritis. Acta Chir. Scandinavica, LXXXIII (Supplementum 58), 1939.

TRANSPLANTATION OF THE EXTENSOR TENDON FOR CORRECTION OF THE OVERLAPPING FIFTH TOE

BY PAUL W. LAPIDUS, M.D., F.A.C.S., NEW YORK, N. Y.

From the Hospital for Joint Diseases and the New York Polyclinic Medical School and Hospital,† New York*

The purpose of this paper is to present an operative procedure which has been performed in a few cases since February 1936 with satisfactory results. Although "overlapping fifth toe" is a well-known deformity, it seems to be worth analyzing in a more detailed manner. As the name itself implies, the fifth toe overlaps upon the dorsal aspect of the fourth toe. Often the congenital nature of this condition can be definitely established, and sometimes it is also hereditary. There are three main components of the deformity:

1. Adduction contracture of the fifth toe toward the fourth,
2. Dorsiflexion contracture of the fifth toe at the metatarsophalangeal joint,
3. External rotation of the fifth toe around its long axis, so that its nail faces laterally.

All these changes take place mainly at the metatarsophalangeal joint of the fifth toe. Adduction may also be present at the proximal interphalangeal joint.

In all of these cases the medial (tibial) collateral ligament, and the dorsal and medial part of the capsule of the metatarsophalangeal joint are shortened. In some cases with marked deformity, the skin surrounding the web is also contracted. Usually the extensor tendon of the fifth toe is shortened and displaced medially. The fifth toe has only one extensor tendon, supplied by the extensor digitorum longus. The extensor digitorum brevis tendon for the fifth toe is, as a rule, absent in the human foot. The whole toe often appears to be smaller, and the toe nail shorter and flatter than normal. In addition to this, the cylindrical form of the fifth toe is frequently lost; the toe appears to be flattened in the dorsoplantar direction, being paddle-shaped. The plantar surface of the paddle is not horizontal, but approaches a vertical plane, hugging the dorsolateral surface of the fourth toe.

Not infrequently people with this deformity are able to go through life wearing custom-made shoes, and engaging in occupations requiring strenuous use of their feet, without any discomfort whatsoever. The Civil-Service regulations consider a person with an overlapping fifth toe as unfit for service, and require correction before the candidate is accepted. It appears to the writer that the potential disability inherent in this deformity seems to be somewhat overestimated. Nevertheless, some individuals seek professional advice, and are willing to

* Service of Leo Mayer, M.D. † Service of J. J. Nutt, M.D.

submit themselves to an operative correction, because of discomfort, due to pressure of the shoe, and painful corns over the dorsum of the fifth toe, or soft corns between the fourth and fifth toes; or for cosmetic reasons. A number of patients request the operation because their applications for service in the Police or Fire Department have been rejected.

In one of the author's cases, a girl eight and one-half years old (not operated upon), the overlapping fifth toe was on the side of a mild transient hemiplegia following birth injury (breech presentation).

Another patient, a young woman, twenty-three years old, with fairly well-corrected congenital club feet (worse on the right side) presented marked overlapping of the left fifth toe. The paternal grandfather of this patient was said to have a similar deformity of the fifth toe. Operative correction of the left fifth toe with satisfactory result was performed in this case on February 28, 1936. (The patient was last seen on May 5, 1939.)

Conservative treatment consists of padding and the application of salicylic-acid ointment (30 to 50 per cent.) for removal of painful corns, in addition to a shoe allowing adequate room for the fifth toe.

The operative approach which is offered is devised to correct the three components of the deformity, that is:

1. To abduct the toe,
2. To flex it plantarly,
3. To rotate it internally.

DESCRIPTION OF OPERATION

The skin of the foot is prepared with Whitfield's ointment for at least one week before the operation. No tourniquet is used. A local block anaesthesia over the level of the fifth metatarsal base is given, with no novocain solution being injected at the operative field. A longitudinal hockey-stick incision (Fig. 1-A) is made along the dorsomedial border of the fifth toe, starting from the region of the distal interphalangeal joint and running proximally to the web between the fourth and fifth toes. From here the hook of the hockey stick is added by running the incision over the dorsum of the fifth metatarsophalangeal joint laterally, and in a proximal direction to the lateral aspect of the fifth metatarsal head. The skin over this region is rather thin, and care should be taken not to cut the underlying aponeurotic expansion of the extensor tendon. The extensor tendon is carefully dissected without damaging its insertion. The fifth toe is flexed plantarly, so that its extensor longus tendon becomes taut and projects beneath the skin. A transverse incision about one centimeter long is then made over the prominent tendon at the level approximately corresponding to the middle of the fifth metatarsal bone. The extensor longus tendon of the fifth toe is identified by moving the toe. It is cut transversely, and its free distal stump gently pulled out into the wound over the fifth toe (Fig. 1-B). The tendon is then completely freed and followed to its insertion into the nail phalanx. Special care should be

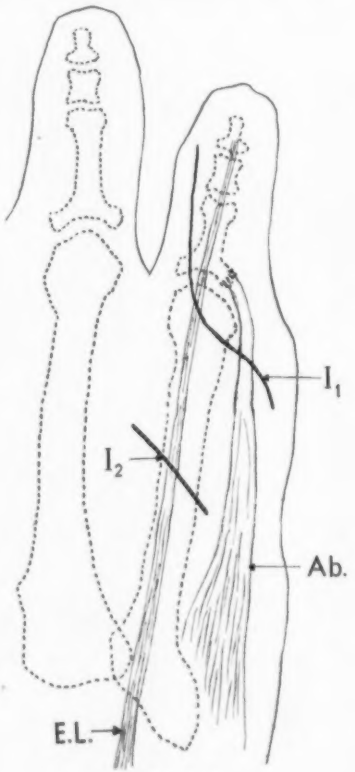

FIG. 1-A

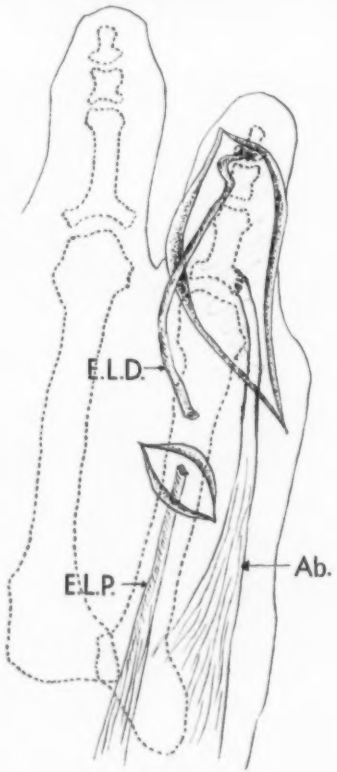

FIG. 1-B

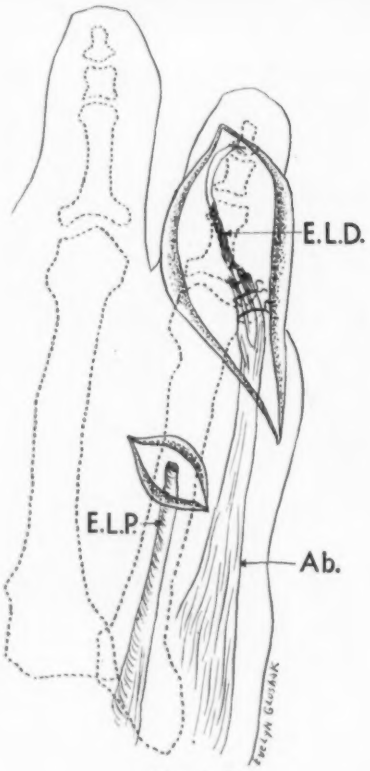

FIG. 1-C

Schematic drawings of the operative procedure showing the dorsal view of the fourth and fifth toes.

Fig. 1-A: I_1 and I_2 represent the two skin incisions; *E.L.*, the extensor longus tendon; *Ab.*, the abductor digiti quinti.

Fig. 1-B: *E.L.D.* represents the distal stump of the extensor longus tendon, which was pulled out into the wound over the fifth toe; *E.L.P.*, the proximal stump of the extensor longus tendon.

Fig. 1-C: The distal stump of the extensor longus tendon (*E.L.D.*) is translocated medially and plantarly (plantar part is crossed transversely), and its end is sutured into a slot made in the tendon of the abductor digiti quinti (*Ab.*).

FIG. 2-A FIG. 2-B

Overlapping congenital right fifth toe in a girl, ten years old.

FIG. 2-C FIG. 2-D

Both feet, of the same patient as shown in Figs. 2-A and 2-B, one year after the operation (performed on April 26, 1939), showing the normal appearance of the right fifth toe. Note also the mild deformity of the left fifth toe (Fig. 2-C) which was not operated upon.

exercised to preserve the tendinous insertion. The capsule of the fifth metatarsophalangeal joint is exposed bluntly, and cut transversely on its dorsal and medial aspect where it is usually contracted. This capsulotomy should be thoroughly performed, so that afterward the dorsiflexion and adduction deformity of the fifth toe is entirely corrected, and remains so without any external support. An oblique subcutaneous channel is then prepared with a blunt instrument. This channel starts near the distal interphalangeal joint on the dorsomedial aspect of the toe, and

winds around its plantar surface in a proximal and lateral direction, emerging on the plantar lateral aspect of the fifth metatarsophalangeal joint. The tendon of the extensor of the fifth toe is now passed through the channel so that it encircles the plantar surface of the fifth toe in an oblique spiral fashion. The conjoined tendon of the abductor and the short flexor of the fifth toe is then split longitudinally, and the free end of the translocated extensor tendon is buried and sutured to the conjoined tendon (Fig. 1-C). Some tension is put on the transplanted extensor tendon, and all the three components of the deformity of the fifth toe are slightly overcorrected while the tendon is sutured. The skin is then loosely united with interrupted stitches. In marked cases with extensive skin contracture, it is sometimes necessary to shift the opposite edges of the skin against each other before suturing them, or even to do some additional plastic surgery to compensate for the insufficiency of the skin. The toe is immobilized by means of a short, steel, corset splint which can be molded to the required shape. Extreme gentleness and a completely atraumatic technique will insure proper healing.

AFTER-TREATMENT

The circulation of the toe, of course, must be carefully supervised. In order to allow for postoperative swelling, the splint should not be too tightly strapped to the toe. Adequate correction must be obtained by the surgical procedure, and not by the subsequent splinting. The only purpose of immobilization is to maintain the correction until healing takes place. At the end of a week, the dressing is changed and the splint is reapplied (for about three or four weeks), and the patient may be allowed out of bed with a shoe cut out over the fifth toe.

The results in a few cases have been quite satisfactory, so that the author feels justified in offering the above procedure for general use.

Disarticulation of the fifth toe must be warned against. In at least two cases (operated upon by another surgeon and followed by the author) the results were very discouraging. A painful steplike prominence of the fifth metatarsal head was more disabling than the original deformity.

SUMMARY

An operative procedure for correction of overlapping fifth toe consists in running the distal stump of the extensor longus tendon, with its insertion intact, through an oblique spiral channel across the plantar surface of the toe, and implanting it into the conjoined tendon of the abductor and short flexor of the fifth toe, after dorsal and medial capsulotomy of the fifth metarsophalangeal joint. The operative procedure seems to be mechanically sound, because it not only corrects the main three components of the deformity, but also utilizes the muscle power of the abductor and short flexor for active maintenance of the correction.

REFERENCE

STRACKER, O.: Digitus quintus superductus pedis. Ztschr. f. Orthop. Chir., LI, 174, 1929.

FRACTURES AND FRACTURE-DISLOCATIONS OF THE ASTRAGALUS (TALUS)*

BY ROBERT D. SCHROCK, M.D., HERMAN F. JOHNSON, M.D., AND CHESTER H. WATERS, JR., M.D., OMAHA, NEBRASKA

From the Department of Orthopaedic Surgery, University of Nebraska College of Medicine, Omaha

The marked dysfunction secondary to injuries of the astragalus (talus) demands further study and correlation of opinions if we are to conserve better function. As shown in an analysis of tarsal fractures by Shands in 1931, fractures and dislocations of the astragalus comprise approximately one-third, and fractures of the os calcis about one-half of the injuries to the tarsal bones. Many reports have been made of individual cases of this disabling lesion, but few of the study of collected cases of fractures and fracture-dislocations of the astragalus.

In 1906 in Toronto under the Presidency of B. E. McKenzie, M.D., Ely presented to The American Orthopaedic Association, "Old Fracture of the Tarsus: With a Report of Seventeen Cases", five of which were fractures of the astragalus. At that time, Ely lamented the inaccuracy of diagnosis in these injuries. He lamented also the tremendous disability subsequent to the complicated fractures of the astragalus. With improvement in diagnostic facilities, the former lamentation has been well answered. Errors in detailed diagnosis are now infrequent. Effective therapy has not kept pace, however, with the increased accuracy of diagnosis.

Sneed of New York reported, in 1925, the first reduction and retention of a dislocated astragalus. The retention of the astragalus was against his better judgment. He presented at that time a study on the circulation of the astragalus.

In 1929, Graham and Faulkner reported a series of ten astragalectomies in patients with fractures of the astragalus, but these cases had been seen late. Of these feet, five were stable and painless; the results in two were fairly good, and in three were disappointing.

In 1932, Phemister presented, "Transplantation of the Astragalus and Demonstration of Aseptic Necrosis".

In 1939, McKeever of Los Angeles in an excellent thesis, as yet unpublished, reported a study of eighteen cases of fracture of the neck and body of the astragalus, with follow-up from nine months to eleven years. He made a splendid study of the blood supply to the astragalus, demonstrating that the "entire vascular supply of the astragalus is derived from branches of the anterior tibial artery. There is evidence also, that the artery, which eventually breaks up into several nutrient arteries, is carried in the dense superior astragaloscaphoid ligament, which extends as a broad band from the dorsal surface of the neck of the astragalus to the dorsal

* Presented at the Annual Meeting of The American Orthopaedic Association, Toronto, Ontario, June 11, 1941.

periphery of the scaphoid. In this ligament, the artery divides into several (two to four) smaller arteries which perforate the supermedial aspect of the neck of the astragalus, where foraminae are clearly present.

"No evidence of arteries perforating either the posterior or anterior calcaneo-astragaloid ligament or from the internal calcaneo-astragaloid ligament in the subastragalar joints was apparent. In no instance was it possible to demonstrate arteries throughout the body of the astragalus."

In seventeen of McKeever's cases, varying degrees of aseptic necrosis were evident.

Speed and Smith in 1939 set forth dependable generalizations with reference to fractures and dislocations of the astragalus.

Again in 1939, Miller and Baker presented a detailed analysis of thirty cases of fracture-dislocation of the astragalus. They advocate certain definite procedures, and in conclusion they state:

"1. Treat simple fractures of the astragalus simply. . . .

"2. Do early accurate open reductions on fractures of the astragalus when there is displacement of fragments or derangement of the articular surfaces. When entirely satisfactory reduction cannot be obtained, subastragalar [triple] arthrodesis should be considered as an early measure. Panarthrodesis is sometimes necessary."

Miller and Baker advocate, in those cases where subastragalar arthrodesis is indicated, that calcaneocuboid arthrodesis and astragaloscaphoid arthrodesis be added. (If the cartilage surfaces of these two joints are relatively intact, the present authors feel that the triple arthrodesis should not be done, but that mobility should be retained in both the calcaneocuboid and astragaloscaphoid joints.) Miller and Baker continue:

"3. After closed or open reductions, do arthrodesing operations if painful joints develop.

"4. Do not do astragalectomies except in the presence of frank infections."

In the series of cases presented herewith (Table I) there were ten astragalectomies.

The technique of astragalectomy as devised by Royal Whitman for paralytic calcaneovalgus has been applied directly to astragalectomy where the pathology is traumatic. It is evident the two conditions are not comparable. In the paralytic calcaneovalgus foot, the muscle support is unbalanced with major weakness in the plantar flexors and adductors of the foot. In fractures of the astragalus, the musculature is intact and retains its physiological balance. Mobility of the mid-tarsal joints should be retained.

Where astragalectomy is essential because of trauma, better function is obtained by maintaining the foot forward where the anterior margin of the tibia is in the vertical plane with the calcaneocuboid joint. The redundant soft parts normally about the neck and head of the astragalus will then give a soft-part buffer between the tibia and the scaphoid. Greater mobility of the mid-foot is maintained.

From the series of thirty cases of fracture and fracture-dislocation of the astragalus, seven representative case reports are given in detail.

FIG. 1-A

Case 1. B. C. November 29, 1933. Fracture of the neck of the right astragalus.

FIG. 1-B

Case 1. B. C. May 9, 1941. Moderate sclerosis of the body eight years after injury. There are no arthritic changes; function is excellent.

CASE 1. B. C. A male, thirty-four years old, suffered a displaced fracture through the base of the neck of the right astragalus and a chip fracture of the body of the left astragalus, from a fifteen-foot fall, November 29, 1933 (Fig. 1-A). The fracture of the right astragalus was reduced by manipulation, and was immobilized in a plaster boot for ten weeks. The undisplaced fracture of the left astragalus was treated by simple immobilization in plaster for six weeks. The end result, as determined April 25, 1941, is considered excellent; the patient was walking without any limp and was working ten hours daily as a carpenter.

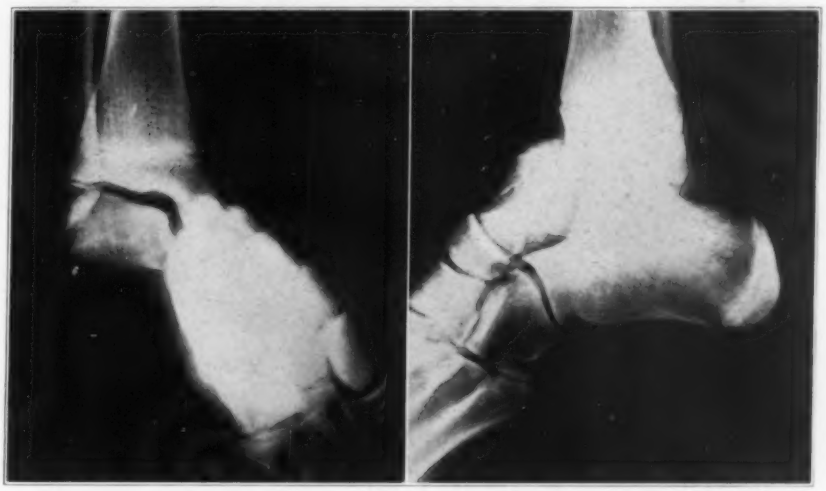

FIG. 2-A

Case 2. D. D. March 31, 1940. Horizontal fracture through the body of the right astragalus.

FIG. 2-B

Case 2. D. D. April 26, 1941. Union is complete with only slight sclerosis of the body and irregularity of the dome. Perfect functional result.

CASE 2. D. D. A boy, fourteen years old, fell from a cliff March 31, 1940, sustaining a horizontal fracture through the body of the right astragalus with medial displacement (Fig. 2-A). The fracture was reduced by manipulation, and was immobilized in a plaster boot for eight weeks. End result May 11, 1941, showed no limp, pain, or disability.

CASE 3. J. J. S. A man, aged forty-five, sustained a linear fracture through the body of the left astragalus from a severe twisting injury to the left ankle January 20, 1940

FIG. 3-A

Case 3. J. J. S. January 20, 1940. Vertical fracture through the body of the left astragalus.

FIG. 3-B

Case 3. J. J. S. January 22, 1940. Reduction with fixation by metal pin.

(Fig. 3-A). Open reduction with internal fixation was performed after forty-eight hours (Fig. 3-B) and the ankle was immobilized in plaster for nine weeks. Examination May 11, 1941, showed the patient walking with a slight limp, and having some limitation of ankle and subastragalar motions. He had some pain, but was working full time as a salesman. The end result is considered fair to good.

FIG. 3-C

Case 3. J. J. S. April 29, 1941. Appearance fifteen months after injury, showing some flattening of the dome of the astragalus and narrowing of the joint space. Function is fair.

FIG. 4-A

Case 4. M. M. April 21, 1925. Severely comminuted fracture-dislocation of the right astragalus.

CASE 4. M. M. A girl, twenty years old, sustained a markedly comminuted simple fracture-dislocation of the right astragalus when struck by a car, April 21, 1925 (Fig. 4-A). Astragalectomy with temporary internal fixation was performed May 6, 1925 (Fig. 4-B). The end result, in May 1941, showed that the patient had developed a marked equinus, although she walked without limp or pain in moderately high-heeled shoes (Fig. 4-C). This case illustrates the fact that in the non-paralytic foot, where astragalectomy is performed, the posterior displacement of the foot should not be carried to the extreme.

FIG. 4-B

Case 4. M. M. June 22, 1925. Two months following astragalectomy and fixation with steel pin.

FIG. 4-C

Case 4. M. M. May 3, 1941. Exaggerated equinus position sixteen years after injury. There is excellent, painless function.

CASE 5. P. A. A man, thirty-one years old, suffered an astragaloscaphoid dislocation on the right in a car accident, December 11, 1938 (Fig. 5-A). Reduction was performed twenty-four hours later and maintained by plaster fixation for three weeks. In February 1939, examination showed normal, painless motion.

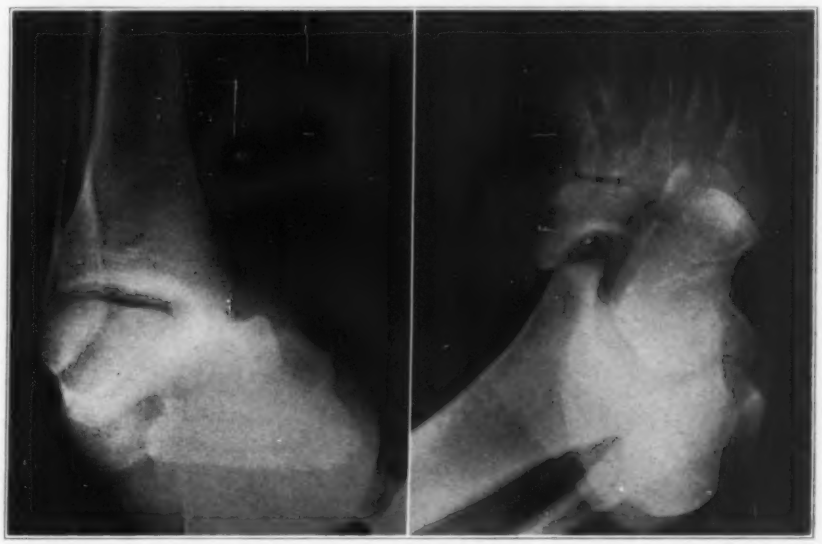

FIG. 5-A

Case 5. P. A. December 11, 1938. Astragaloscaphoid dislocation on the right.

FIG. 5-B

Case 5. P. A. May 9, 1941. Two and one-half years after injury, the end result is excellent.

CASE 6. G. C. A man, nineteen years old, sustained bilateral comminuted fractures of the astragali, the left being compound, in an airplane crash, October 10, 1940 (Figs. 6-A and 6-B). Astragalectomy on the left, and astragaloscaphoid and subastragalar arthrodesis on the right were performed. In May 1941, the patient was getting about fairly well, wearing ankle braces which allowed limited motion. There was still

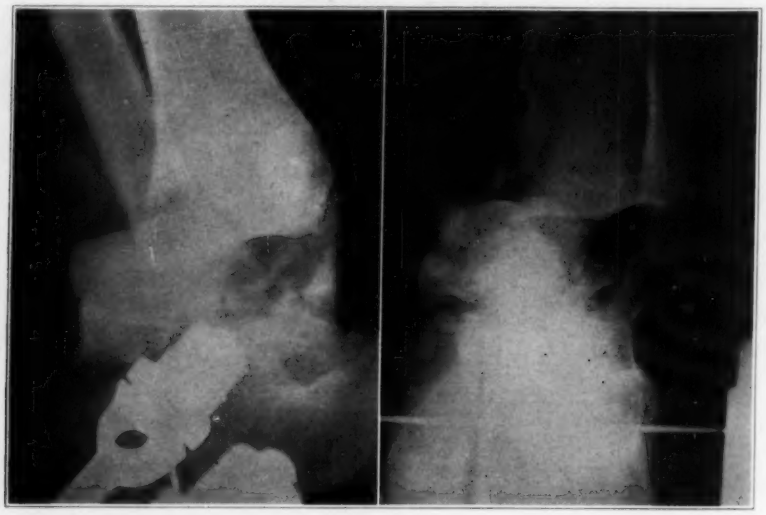

FIG. 6-A

Case 6. G. C. October 10, 1940. Compound, comminuted fracture-dislocation of the left astragalus.

FIG. 6-B

Case 6. G. C. December 2, 1940. Comminuted fracture of the right astragalus in same patient as shown in Figure 6-A, two months after injury. Note the sclerosis of the body.

slight drainage from the left ankle, and the right was painless with partial weight-bearing, although fusion was incomplete (Figs. 6-C and 6-D).

FIG. 6-C

Case 6. G. C. May 12, 1941. Seven months after astragalectomy on the left.

FIG. 6-D

Case 6. G. C. May 12, 1941. Five months after subastragalar arthrodesis on the right. Fusion is incomplete.

CASE 7. C. H. A man, twenty-five years old, sustained a complete external dislocation of the left astragalus with chip fracture of the head, in an airplane crash, May 25, 1930 (Fig. 7-A). Manipulative reduction was unsuccessful, and open reduction was performed May 31, 1930. Aseptic necrosis and drainage from the operative site developed several months later (Fig. 7-B). On December 22, 1930, astragalectomy was performed, followed by plaster fixation for twelve weeks (Fig. 7-C). The end result on April 30, 1941, was excellent functionally, although there was a tibiocalcaneal fusion and some thickening of the foot (Fig. 7-D). The patient walked without a limp and worked on his feet all day as a salesman, without pain or handicap.

FIG. 7-A

Case 7. C. H. May 25, 1930. Subastragalar and astragaloscaphoid dislocation on the left with chip fracture of the head of the astragalus.

FIG. 7-B

Case 7. C. H. December 1930. Aseptic necrosis of the body of the astragalus seven months following open reduction.

Eleven years after operation, this case presents the best functional result in the series of ten necessary astragalectomies. Other observers report their most satisfactory functional results in those cases in which fusion of the tibia and the os calcis has taken place.

As a result of these studies, the authors recommend the following procedure in case astragalectomy seems essential. An immediate cal-

caneotibial arthrodesis is done, using, if available, a portion of the astragalus as a surface adaptor or wedge to decrease the amount of shortening in the extremity. The tibia is placed with its anterior margin in the vertical plane of the calcaneocuboid joint, and the foot is placed in the optimum position for the individual patient. In males, a minor degree of equinus (5 degrees) may be desirable; in females, the degree of the equinus used varies with their social status, but rarely is in excess of 15 degrees (Fig. 8). In the review of the literature referring to injuries to the astragalus, the authors have not found these principles previously described.

Complicating these injuries of the astragalus, a traumatic arthritis of the tibio-astragalar joint is relatively constant. It is reasonable to believe that compression injuries producing fracture-dislocations of the astragalus, would exert sufficient force upon the chondral surface of the tibia and the dome of the astragalus to produce impacted fractures or infractions of these cartilage surfaces. Restitution of the cartilage to its normal status does not occur. It is the authors' feeling that the traumatic arthritis of the

FIG. 7-C

Case 7. C. H. Shows foot after astragalectomy.

FIG. 7-D

Case 7. C. H. April 30, 1941. Tibiocalcaneal fusion eleven years after injury. Function is excellent.

tibio-astragalar joint is produced as much by the initial injury as by the pathology subsequent to inadequate nutrition of the astragalus itself. The degree of pain and disability from this traumatic arthritis is the determining factor in deciding whether or not tibio-astragalar fusion should be done. In this series of cases, the necessity for this operation has not yet been encountered.

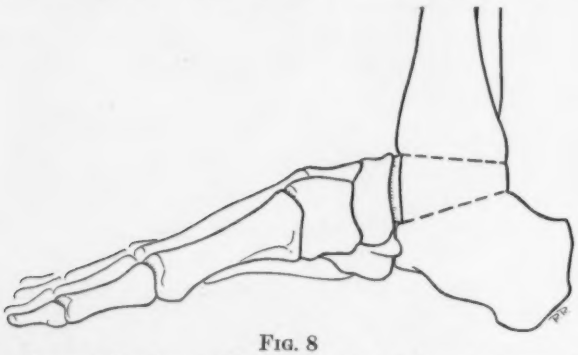

FIG. 8

Suggested calcaneotibial arthrodesis, using a portion of the astragalus as a wedge adaptor.

TABLE I

ANALYSIS OF THIRTY-TWO LESIONS IN THIRTY PATIENTS *

Injury	No. of Cases	Complications	Treatment		Result	
Fracture of the neck	6	—	Manipulation Open reduction	5 1	Excellent Good	5 1
Chip fractures of the head	4	—	Manipulation Excision fragment	3 1	Excellent Good	3 1
Linear fractures of the body	3	—	Manipulation Open reduction	2 1	Excellent Fair	2 1
Comminuted fractures of the body	12	Compound (5)	Astragalectomy Resection and arthrodesis Débridement and reduction	10 1 1	Excellent Good Poor Death Too early	3 3 1 1 4
Dislocations	7	Minor fractures (5)	Manipulation Open reduction	3 4	Excellent Good	5 2

* There were 24 males and 6 females. The average age was 32.8 years.

SUMMARY

1. The blood supply to the astragalus is relatively poor, and transcervical fractures of the astragalus interrupt this blood supply.

2. Revascularization, after injury of the astragalus, is very tardy, and hence there is a high incidence of aseptic necrosis of varying degree, noticeable particularly in the body.

3. There is the necessity of early, anatomical reduction by manipulation or by open reduction, with or without internal fixation as indicated by the stability of the fragments. The articular dome of the body must be smooth and the calcaneo-astragaloid surfaces accurately apposed.

4. In those cases in which subastragalar contact is faulty, immediate subastragalar arthrodesis is indicated to obtain earlier function and to prevent a painful weight-bearing foot. Tibio-astragalar arthrodesis is indicated when there has been demonstrable damage to these cartilage surfaces.

5. In those rare compound dislocations with minor fractures, careful cleansing, detailed débridement, coupled with the local and general administration of sulfonamide derivatives, gives a greater chance for successful conservative surgery.

6. In those compound, badly comminuted fractures, the same technique gives a reasonable chance for immediate reconstruction.

7. In certain simple or compound, but severely comminuted, fractures of the astragalus, reduction and retention of the multiple fragments is impossible. Astragalectomy or calcaneotibial arthrodesis seems a necessity.

8. Calcaneotibial arthrodesis, according to the principles outlined, would appear to offer a more satisfactory result than astragalectomy.

REFERENCES

ELY, L. W.: Old Fracture of the Tarsus: With a Report of Seventeen Cases. Ann. Surg., XLV, 69, 1907.

GRAHAM, W. T., AND FAULKNER, D. M.: Astragalectomy for Fractures of the Astragalus. Ann. Surg., LXXXIX, 435, 1929.

MCKEEVER, F. M.: Fracture of the Neck of the Astragalus (unpublished thesis), 1939.

MILLER, O. L., AND BAKER, L. D.: Fracture and Fracture-Dislocation of the Astragalus. Southern Med. J., XXXII, 125, 1939.

PHEMISTER, D. B.: Transplantation of the Astragalus and Demonstration of Aseptic Necrosis. Alpha Omega Alpha Lecture, 1932. (Unpublished.)

SHANDS, A. R., JR.: Fractures and Dislocations of the Tarsus: An Analysis of a Series of 109 Cases. Southern Med. J., XXIV, 1019, 1931.

SNEED, W. L.: The Astragalus. A Case of Dislocation, Excision, and Replacement. An Attempt to Demonstrate the Circulation in This Bone. J. Bone and Joint Surg., VII, 384, Apr. 1925.

SPEED, J. S., AND SMITH, HUGH: Emergency Treatment of Fractures and Fracture-Dislocations of the Ankle. Am. J. Surg., XLVI, 700, 1939.

THE OPERATIVE TREATMENT OF RELAXED WEAK FEET

BY RALPH R. FITCH, M.D., AND BYRON B. KING, M.D., ROCHESTER, NEW YORK

The problem of the treatment of relaxed, pronated feet is at times difficult to solve. A procedure which is really based on a combination of the principles of the treatment described by Kidner and by Lowman has been devised by one of us (R. R. F.), and has proved useful in certain cases that have failed to respond to non-operative treatment. No claim for originality is made. The procedure is termed "the anterior and posterior tibial tendon transposition".

If the foot cannot be easily dorsiflexed passively to 90 degrees (with the tarsal joints locked by inverting the foot), the calcaneal tendon is lengthened the required amount. Then a three-inch curved incision, with convexity plantarward, permits an exposure of the medial portion of the scaphoid (navicular), and the insertions of the anterior tibial and posterior tibial tendons. If an accessory bone (os tibiale externum) overlying the scaphoid tubercle is present, it is freed from the posterior tibial tendon by sharp dissection, and is excised. If the tubercle of the scaphoid is unduly prominent, an adequate portion of its medial aspect is removed. The posterior tibial tendon is stripped from its attachment to the scaphoid, and its insertion is divided. The periosteum overlying the medial and inferior aspects of the scaphoid is incised and stripped up. With a small gouge, a groove is made in the posterior and inferior surfaces of the scaphoid. The sheath of the anterior tibial tendon is opened, and, with a small hook, the anterior tibial tendon is pulled medially over the tuberosity of the scaphoid, and is allowed to snap into the groove prepared for it. This changes its functional insertion to the highest point of the medial longitudinal arch. The periosteum is then resutured over the scaphoid, and the posterior tibial tendon is reattached at a point more distal and more plantarward than its original insertion. The wound is then closed, and a plaster cast from the toes to the mid-thigh is applied with the foot in 90 degrees' dorsiflexion. As the plaster sets, the forefoot is pronated and adducted, while the heel is molded into varus, thus making the best possible longitudinal arch. At the end of three weeks the cast is cut below the knee, and at the end of an additional five weeks the cast is removed. The patient then gradually begins weight-bearing, using a well-fitting arch support which is discarded five or six months later.

To date, only feet giving rise to symptoms of pain and fatigue have been subjected to this method of treatment. In the few patients operated upon, the symptoms have been relieved, and the foot posture has been improved. The authors feel that this procedure is best suited for feet with faulty foot posture and depressed longitudinal arches, rather than for feet with completely flattened longitudinal arches. It is advisable to confine its use to the relaxed type of weak feet; it should not be used for the spastic (rigid) type of weak feet.

Both feet were operated upon in one patient, and one foot was operated upon in three patients. The fifth patient has had one foot operated upon, and will have the other foot done in the future. The patients at the time of operation were ten, fifteen, seventeen, seventeen, and twenty-

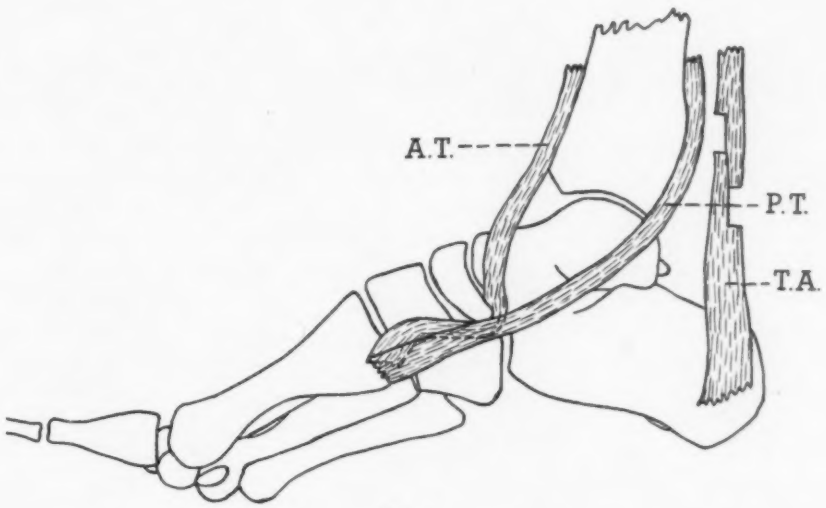

FIG. 1

Diagram of relationships after anterior and posterior tibial tendon transposition. The tendo achillis has been lengthened.

three years of age, respectively. There were two females and three males. They have been followed for two years and two months, one year and eight months, one year and seven months, one year and one month, and seven months, respectively, since operation.

REFERENCES

KIDNER, F. C.: The Prehallux in Relation to Flatfoot. J. Am. Med. Assn., CI, 1539, 1933.

LOWMAN, C. L.: An Operative Method for Correction of Certain Forms of Flatfoot. J. Am. Med. Assn., LXXXI, 1500, 1923.

SURGICAL TREATMENT OF THE RESIDUAL DEFORMITY FROM SUPPURATIVE ARTHRITIS OF THE HIP OCCURRING IN YOUNG CHILDREN

BY PAUL H. HARMON, PH.D., M.D., SAYRE, PENNSYLVANIA

From the Division of Orthopaedic Surgery, The Department of Surgery, The University of Chicago

Because of the large amount of cartilage in the component structures of the hip in young children, suppuration within the joint during the first two years of life runs a benign acute course as compared with the same disease during later childhood and adolescence. General recognition of the comparatively benign course of suppurative arthritis of the hip in young children has not occurred until recent years, when roentgenographic study of crippling disorders has become a commonplace procedure. The first recognition of the condition is frequently delayed until the child begins to walk, when the pathological dislocation of the hip is seen. As far as can be determined from the literature, Slowick was the first to set aside such a condition as an entity. The studies of Badgley, Yglesias, Perham, and Snyder and of Harmon and Adams upon 113 and 147 cases, respectively, of suppurative arthritis of the hip yielded data upon the natural course of this disease in untreated cases of all age groups and upon the course of the disease as modified by careful treatment. L'Episcopo pointed out the reconstructive possibilities in children, and proposed an operation to remedy the defect, which is a loss of the femoral head and neck. However, all of his cases were children several years older than those to be presented in this report. Only Hallock's report of the experience at the New York Orthopaedic Dispensary and Hospital with arthroplasty and reconstruction operations of the hip describes a reconstruction operation upon a young child similar to one of the cases to be described below. This last mentioned author operated upon a child one and a half years of age, suffering from the effects of suppurative arthritis and dislocation of the hip. His patient, however, presented a remnant of a femoral neck which was utilized in the reconstruction procedure. None of these previous authors appears to have recognized the unique potentialities of growth of the upper femur in the very young child, which can be utilized only if this type of pathological dislocation is recognized at an early age and treated promptly by operation.

CLINICAL COURSE OF ACUTE SUPPURATIVE ARTHRITIS IN THE VERY YOUNG CHILD

The general physician treats most of these cases, because the illness is usually not a severe one, and the condition is often mistaken for an abscess in the region. He is further misled by the rapidity with which the incised wound closes, as it usually heals in one or two weeks. With

subsiding inflammation, the child rapidly recovers from the infection. The damage that is done at this time does not become evident until the hip lurch produced by dislocation is seen for the first time when the child becomes ambulatory at the end of the first year of life. In order to understand fully the widespread destruction of the upper femur, when the original disturbance has been of a minor degree, it is necessary to recall that the upper femur, at this age, is largely, if not entirely, cartilage. The cartilage is readily destroyed in the presence of a pyogenic exudate[11], inasmuch as a tryptic ferment is present, which dissolves cartilage. This sequence of events is illustrated by both of the following case histories:

CASE 1. E. C. was first seen at the Clinic of the Home for Destitute Crippled Children, of the University of Chicago, at the age of twenty months. The mother stated that at the age of twenty-three days a swelling appeared upon the buttocks, accompanied by a high fever and temporary muscle spasm about the hip. The swelling was incised, and purulent drainage followed. Inasmuch as

FIG. 1-A

Case 1. E. C. Roentgenogram taken six months prior to operation, at the age of twenty months. Dislocation is evident from this view, but whether a remnant of neck remains, preformed in cartilage, cannot be positively ascertained.

FIG. 1-B

Case 1. E. C. Roentgenogram taken through plaster immediately after execution of the reconstruction operation. The bone grafts are well demonstrated.

roentgenograms were said to show no bone changes, a fact which was subsequently verified, the mother was told that this was merely a "boil upon the buttocks". The mother was concerned with the limp which the child had had since the age of one year, and she requested an explanation of it.

Roentgenograms (Fig. 1-A) gave the explanation. The shadows of the head and neck of the right femur were missing, and the greater trochanter was displaced upward.

FIG. 1-C

Case 1. E. C. Five months after operation, and two months after removal from plaster and resumption of weight-bearing.

FIG. 1-D

Case 1. E. C. Three years and eight months after operation. Note the maintenance of joint space in the reconstructed hip. The greater trochanter, however, has continued to grow in a superior direction.

Examination showed unrestricted passive motion at the right hip. The right greater trochanter ascended to a slight degree, when attempts were made to telescope the right leg upon the trunk. The right leg measured (anterior superior iliac spine to internal malleolus) thirty-seven and five-tenths centimeters, while the corresponding measurement upon the left was thirty-nine and five-tenths centimeters.

The patient was admitted to the Hospital, and on April 2, 1937, an attempt was made to reduce a hypothetical cartilaginous femoral head into the right acetabulum. When this failed, an open operation was performed. The hip was approached by the anterior route, the sartorius being retracted medially. After the joint capsule, which was adherent to the lateral surface of the ilium, had been opened, the true situation was seen. There was no femoral head or neck. The medial surface of the upper shaft, formerly the junction of the neck and shaft, was covered by fibrocartilage. The acetabulum was filled with soft proliferated synovial tissue, but, following the removal of all soft tissues, its depth was found unreduced. The reconstruction operation to be described (Figs. 1-B and 3-B) was then carried out. The incision was closed in layers in the usual manner, after the leg had been abducted and the position of the medial fragment in the acetabulum had been verified. The cast was allowed to remain in place for three months, after which the patient was permitted to become ambulatory with crutches. Six months after the operation (Fig. 1-C) he was walking with a slight limp, but without support. He continued to improve, so that nine months after operation no limp was present. For the following two years the patient walked without any limp. During this time, roentgenograms showed that the newly formed femoral neck remained beneath the acetabular rim, and the hip remained stable.

FIG. 1-E

Case 1. E. C. Three years and eight months after operation. At this time the patient's gait was excellent except for three and five-tenths centimeters of shortening present in the right leg.

He was last examined on December 17, 1940, (Figs. 1-D and 1-E) at which time his gait was excellent, except for shortening of the leg, which had developed. The measurements of leg length were (anterior superior spine to internal malleolus) fifty-two and five-tenths centimeters on the left and forty-nine centimeters on the right. Ninety degrees of free active flexion from the neutral position was present. There were 10 degrees each of active adduction and abduction, but rotation, while present, was less than 10 degrees. The right greater trochanter was palpable slightly below the level of the anterior superior iliac spine.

CASE 2. D. P. C., male, was seventeen months of age when first seen by the author. The infant was greatly emaciated, the parents stating that his illness of the previous eight weeks had caused loss of almost half his body weight. One week after the onset of the original disorder, which according to the family physician was accompanied by a painful flexion deformity of the left hip and knee, abscesses were incised anterior to the left knee and posterolateral to the left hip. After copious discharge of purulent material, both abscesses healed within ten days. No cultures for bacteria were made.

Upon examination at the age of seventeen months, six weeks after the healing of the wounds, the child would not attempt to stand or walk, and could maintain a sitting position only with aid. The skin was lax over the underlying tissues, and retardation of

development was evident from extensive generalized muscle atrophy, the potbelly, and the wide separation of both the anterior and posterior fontanelles. There was a flexion deformity of 30 degrees at the left knee and 15 degrees at the left hip. Crepitation could be elicited at the left knee. The other joints were normal. Measurements from both the umbilicus and the anterior superior iliac spine showed the left leg to be three-fourths of an inch shorter than the right. Attempts to produce further apparent shortening by telescoping the left leg upon the trunk failed, this hip being as stable as the normal hip.

Roentgenographic examination (Fig. 2-A) showed upward displacement and irregularity of the left superior acetabular bone cortex (wandering acetabulum). The head of the left femur appeared to be still entirely cartilaginous, but from the relation of

FIG. 2-A

Case 2. D. P. C. At the age of seventeen months.

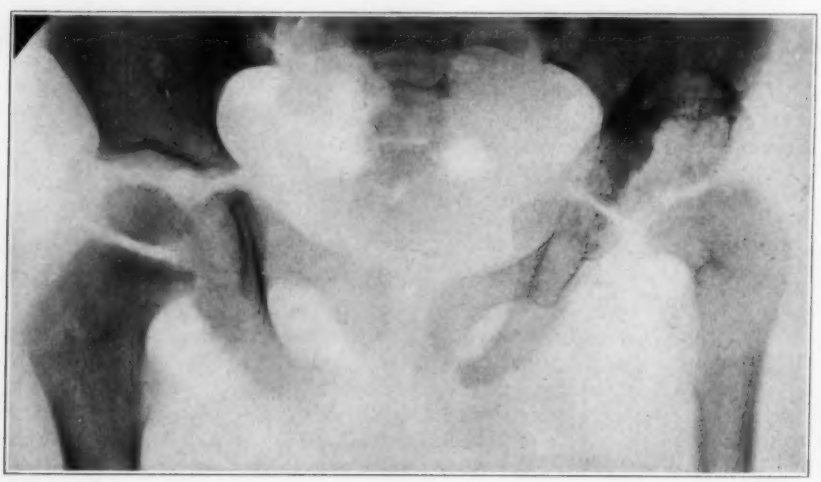

FIG. 2-B

Case 2. D. P. C. At the age of four years and two months. An osseous center has appeared in the upper left femur, which has remained stable in the acetabulum, although the acetabulum has "wandered" during the stage of acute suppuration.

the neck to the acetabulum it was certain that the cartilaginous femoral head was in the acetabulum. A slight coxa vara deformity was present on the left. The femoral deformity and the upward displacement of the acetabulum were sufficient to account for the measured clinical shortening.

In view of the stability of the hip, present because of sufficient preservation of cartilage of the femoral head center, the only indication for treatment was to eliminate the flexion deformities of the left hip and knee. This required four months' recumbency in the Hospital with the left leg in almost constant traction. During this time, the patient regained the general body weight that had been lost, and his general appearance improved because of better nutrition.

He was last seen at the age of four years and two months. At that time, when wearing shoes with a half-inch elevation on the left heel, he walked without a limp. Measurements of leg length showed that no further discrepancy of length (three-quarters of an inch) had occurred in the three years since the first visit. Passive motion at the left hip was free, painless, and normal except in extension, abduction, and adduction, which were limited to about two-thirds of normal. There was no restriction in motion at the left knee and the flexion contracture had not recurred.

Roentgenograms (Fig. 2-B) on this latter date were not dissimilar to those taken three years previously. An osseous center to the upper left femoral epiphysis was now definitely present. No active treatment was indicated except the slight raise on the heel of the left shoe.

OPERATIVE TECHNIQUE

Figures 3-A and 3-B demonstrate the operative attack upon the bone, as carried out in performing the reconstruction of the upper femur in this group of very young children. The anterior and upper fourth of the femoral shaft is bared subperiosteally. The leg is rotated so that the toes are in the anterior vertical plane. This positioning is of importance, since subsequent rotation of the limb depends upon it. The muscles are not stripped from the greater trochanter. From four to six drill holes are placed through both the anterior and posterior cortex, as shown in Figure 3-A. Placement of these holes guides subsequent splitting of the shaft, which is carried out from above downward with a short, thin-bladed osteotome. The medial fragment, which is covered by fibrocartilage, is split medially and brought under the acetabular roof. Any soft tissues projecting into the acetabulum are removed by curettement, care being taken not to injure the cartilage. Bone grafts which have been removed from the opposite tibia are then placed as shown in Figure 3-B,—one being used as a strut across the mouth of the bone incision and the other being wedged into the inferior angle, so as to maintain the fixed separation of the shaft fragments. The muscles are then allowed to fall into place, and those which were partially detached from the anterior ilium are reattached by periosteal stitches of fine plain catgut. The deep fascia and subcutaneous layers are closed by fine plain catgut, and the skin edges are united with a non-absorbable suture.

The technique as described above is applicable only when the acetabulum is undamaged or altered to only a minor degree by preexisting disease, which is usually the case in the group of very young children dealt with in this report. If the acetabular roof is too shallow or is non-existent,

a new acetabulum is prepared by gouge and small ball reamer at the level of the normal contralateral acetabulum. Correct positioning of the new acetabulum can be checked by identification of the remains of the triradiate cartilage. A shallow foreign-body cup is then placed in the newly formed acetabulum. Vitallium has been utilized in hip-joint arthroplasty by Smith-Petersen, while the author has used cups of methacrylate for this purpose. In girls the possibility of pelvic deformity due to closure or distortion of the zone of enchondral ossification should be discussed with the parents when this manoeuvre becomes necessary.

DISCUSSION

These instances of residual suppurative arthritis in the very young child represent a special group from the point of view of the necessity of early diagnosis and continued follow-up, in order to determine the necessity for reconstructive procedures, and to obtain the benefits from reconstruction at an early age. At this age the growth potentialities of bone are great enough so that a necklike structure can result from the operative procedure just described. That the opportunity of seeing these extremely young children at an early age is rare, is attested by the fact that the author encountered but four cases, two of which are described in this report (one not requiring surgery), out of 314 cases of acute and chronic suppurative arthritis of the hip, during the past five years. However, this, it is felt, is due to relatively scant attention paid to crippling conditions in very young children in the past by the general physician. In a review of 147 pyogenic hips in 132 patients reported by Harmon and Adams, there were twenty-two hips (14.9 per cent.) in which the pyogenic process began before the age of three years; the majority began during the first year of life.

FIG. 3-A

Sketch illustrates the appearance of a dislocating hip prior to the operative reconstruction procedure. The location of anteroposterior drill holes in the femoral shaft, outlining the line of the proposed bone incision, is shown.

From the point of view of roentgenographic diagnosis, cases of the type illustrated in Figure 4 (traumatic periostitis in the newborn) might be confused with the dislocating hip of the very young child. Quite rarely the question of osteogenic sarcoma might be raised in the differential diagnosis. This latter condition is indeed a rarity, as the statistics from the Registry of Bone Sarcoma of the American College of Surgeons[4]

show only a single doubtful case in the lower femur of a boy of three, and Geschickter and Copeland report a single case in the upper femur as a congenital osteogenic sarcoma discovered in an infant of forty-six days. Both cases resulted fatally, but the value of either is lessened because a necropsy was not obtained.

Roentgenograms shed much light upon the nature of the process. From them, one can usually establish the presence or absence of dislocation, particularly if a second view is taken while an attempt is being made to telescope the femur into the trunk on the involved side. Boxing the extra acetabular space by lines described by Perkins makes the determination of dislocation more certain when the epiphyseal center is absent or delayed in appearance, or when the cartilage in which it subsequently is to appear has been damaged by the disease. The entire subject of the roentgenography of the infantile hip joint has recently been reviewed by Burman and Clark.

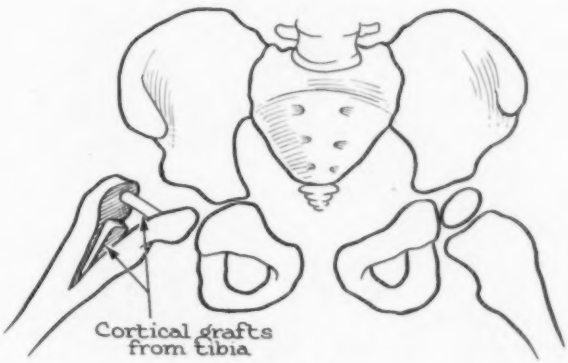

FIG. 3-B

Sketch shows the completed operation upon the bone, and the rôle of the cortical bone grafts from the opposite tibia in maintaining the position of the fragments.

Reference to the roentgenograms of Case 1 shows that a joint space has been maintained in the reconstructed hip for a period of four years. The cartilage space appears in recent roentgenograms (Fig. 1-D) to be of the same width as that of the normal hip. The increase in width and depth of the acetabulum on the side on which the operation was performed appears to be keeping pace with that in the normal hip, although there is more obliquity in the former than in the latter. There is likewise an increase in the transverse diameter from the trochanter to the medial osseous surface of the reconstructed femoral neck, but the trochanter on this side is increasing its superior height at the expense of the neck, and a coxa vara is developing. Experience with cases of active suppuration in children has shown that preservation of stability is maintained where remnants of the partially ossified neck remain after destruction by the suppurative process or epiphysiolysis. By analogy, it is probable that the neck remnant created by reconstruction will be adequate to stabilize the hip for years to come. In the future, the necessity for some procedure to bring about equalization of leg length should be contemplated in this and similar cases.

While the roentgenograms and drawings show the procedure to be similar to that applied by Albee to ununited fractures of the femoral neck,

no "increased leverage" is anticipated, as in the very young child the end result is that of restoring a semblance of the normal contour to the upper femur, and of stabilizing this structure in the acetabulum.

SUMMARY AND CONCLUSIONS

Suppurative arthritis of the hip in the very young child usually runs a benign acute course, but results in destruction of the entire cartilaginous portion of the upper femur. When the child begins to walk, the pathological dislocation so produced is evident.

FIG. 4

Roentgenogram of the pelvis and femora of an infant, two months of age, showing in the right upper femur the changes that have been described as "traumatic ossifying periostitis of the new born". This child was followed by roentgenograms for four years, during which time the changes shown persisted almost unchanged. Full motion was preserved in the right hip.

The presence of the pathological dislocation cannot always be decided from a study of roentgenograms. Physical examination and comparative roentgenographic study of the pelvis, when reverse traction is applied to the abnormal leg, may demonstrate a hip stabilized by sufficient cartilage.

When the presence of a pathological dislocation is demonstrated, good results may be obtained by the type of reconstruction operation described in this report. The optimum time for this operation is during the second and third years of life. Roentgenograms taken prior to operation will demonstrate any internal markings in the bone which might contra-indicate the reconstructive operation.

While only two reconstruction operations upon children so young have been reported (Hallock's case and the one presented here), the amount of articular bone produced, and the subsequent stability of the hip favor the early recognition of these rare cases, and their immediate treatment by reconstruction. The patients should

then be followed closely and appropriate measures should be taken to equalize leg length as indicated.

REFERENCES

1. Albee, F. H.: The Kinesiological Lever in Reconstruction Operations on the Hip. J. Bone and Joint Surg., XXII, 406, Apr. 1940.
2. Badgley, C. E.; Yglesias, Luis; Perham, W. S.; and Snyder, C. H.: Study of the End Results in 113 Cases of Septic Hips. J. Bone and Joint Surg., XVIII, 1047, Oct. 1936.
3. Burman, M. S., and Clark, H. C.: A Roentgenologic Study of the Hip Joint of the Infant in the First Twelve Months of Life with Reference to Early Diagnosis of Its Congenital Dislocation. Am. J. Roentgenol., XLIV, 37, 1940.
4. Crowell, B. C.: Personal Communication.
5. Geschickter, C. F., and Copeland, M. M.: Tumors of Bone. New York, Am. J. Cancer, 1931.
6. Hallock, Halford: A Study and End-Result Report of Seventy Arthroplasties and Reconstruction Operations on the Hip Joint. Surg. Gynec. Obstet., LXVIII, 106, 1939.
7. Harmon, P. H.: Arthroplasty of the Hip with Lucite Cups: Report of Immediate Results. Proc. Institute Med. Chicago, XIII, 413, 1941; Guthrie Clin. Bull., XI, 9, 1941.

   Results During the First Year from Arthroplasty of the Hip with Non-Metallic Foreign Body Cups of Methacrylate. Guthrie Clin. Bull., XI, 120, 1942.
8. Harmon, P. H., and Adams, C. O.: Suppurative Arthritis of the Hip with Special Reference to Pathological Dislocation and Treatment. Proc. Institute Med. Chicago, XI, 224, 1937.

   Pyogenic Arthritis with Special Reference to Dislocation and Treatment. Review of End Results of 147 Involved Joints in 132 Patients. (Paper read at the Seventh Annual Meeting of The American Academy of Orthopaedic Surgeons, Memphis, Tennessee, Jan. 18, 1939.)
9. L'Episcopo, J. B.: Stabilization of Pathological Dislocation of the Hip in Children. J. Bone and Joint Surg., XVIII, 737, July 1936.
10. Perkins, George: Signs by Which to Diagnose Congenital Dislocation of the Hip. Lancet, I, 648, 1928.
11. Phemister, D. B.: The Effect of Pressure on Articular Surfaces in Pyogenic and Tuberculous Arthritides and Its Bearing on Treatment. Ann. Surg., LXXX, 481, 1924.
12. Slowick, F. A.: Purulent Infections of the Hip Joint. An Analysis of Sixty Cases. New England J. Med., CCXII, 672, 1935.
13. Smith-Petersen, M. N.: Arthroplasty of the Hip. A New Method. J. Bone and Joint Surg., XXI, 269, Apr. 1939.
14. Snedecor, S. T.; Knapp, R. E.; and Wilson, H. B.: Traumatic Ossifying Periostitis of the New Born. Surg. Gynec. Obstet., LXI, 385, 1935.

NEUROGENIC SARCOMA *

BY I. H. MASERITZ, M.D., BALTIMORE, MARYLAND

The term neurogenic sarcoma is applied to a group of tumors which have their origin in the connective tissue supporting nerves. These tumors may occur as primary malignant growths, or may arise in a previously existing benign neurofibroma. They are varieties of fibrosarcoma, but possess certain characteristics common to growths of the nerve sheath.

TABLE I

LOCATION OF NERVE-SHEATH SARCOMA IN 192 OF THE CASES PRESENTED

Scalp	3
Face	6
Neck	8
Shoulder	8
Deltoid region	3
Axilla (soft parts)	2
Arm	8
Elbow	2
Forearm	10
Hand	7
Fingers	5
Body wall	8
Chest	4
Abdomen	11
Buttock	4
Hip	7
Thigh	38
Knee	12
Leg	21
Ankle	10
Foot	9
Toes	3
Pubis	2
Mesentery	1
	192

The present series includes 216 cases of solitary primary neurogenic sarcoma of soft parts. Although multiple malignant nerve-tissue tumors have been reported by Herxheimer and Roth, Krause, Cestan, and others, none were observed in the material available for this study.

Stewart and Copeland (1931) reported 130 cases of primary neurogenic sarcoma, sixty-six cases having been collected from the literature and the others taken from the Memorial Hospital, New York City. The nerves in which these tumors originated were specified in the cases

* The data used in this article were collected from the records of the Surgical Pathological Laboratory of the Johns Hopkins Hospital, Baltimore, Maryland.

TABLE II

DURATION OF SYMPTOMS IN SIXTY-EIGHT CASES

Period of Time	No. of Cases
0 to 6 months	23
6 months to 1 year	11
1.5 years	6
2 years	4
3 years	5
4 years	4
5 years	1
6 years	2
7 years	1
8 years	1
9 years	1
10–20 years	7
20–40 years	1
40 years	1
Total	68

collected from the literature, while no origins were given for their own cases. (Table I shows the regions involved by the tumors in the present series.) Stewart and Copeland, Ewing, and others believe that the majority of the so-called fibrosarcomata arising in the extremities and

TABLE III

RECURRENCES

Period of Time	No. of Cases	
	Single Recurrences	Multiple Recurrences*
6 months	15	1
1 year	4	5
1.5 years	4	3
2 years	3	2
3 years	2	2
4 years	5	1
5 years	1	0
6 years	2	0
7 years	1	0
8 years	1	0
10–20 years	0	3
Total	38	17

* Seventeen patients had multiple recurrences, four of whom had more than two recurrences.

body wall are of nerve-sheath origin. The author is of the same opinion, since many sarcomata of the nerve sheath, which arise from unimportant branches of a nerve, and which have no demonstrable anatomical relationship to nerves at the time of operation, present the same gross and microscopic features as those growths which are known to arise from the larger nerves, and as in cases of von Recklinghausen's disease. The location, clinical behavior, and especially the gross and microscopic findings are sufficient evidence of their nerve-sheath origin. The destructive character of these growths makes it impossible in some cases to dissect out the nerves from which they arise.

FIG. 1

P. N. 3981. Clinical photograph in case of neurogenic sarcoma arising from the sciatic nerve.

In the present series of primary sarcomata there were 106 males, 102 females, and eight instances in which the sex was not reported. Thirteen instances occurred in members of the colored race. Age was recorded in only 144 cases. The highest peak was reached in the third decade,—thirty-nine cases. There were ten cases in the first decade; twenty-eight in the second decade; three in the fourth; thirty-three in the fifth; fifteen in the sixth; and sixteen in the seventh. The cases collected by Stewart and Copeland included seventy males and fifty-five females. The majority of cases occurred between twenty and fifty years.

The distribution of the lesions in the author's series varied. The largest group, 149 out of 192 cases in which the sites of the lesions were specified, involved the extremities (Table I). In most instances, the symptoms consisted of a painless swelling. Symptoms resulting from nerve pressure or destruction occurred occasionally. The duration of symptoms in thirty-four, or 50 per cent. of the cases in which such data were recorded, was one year or less (Table II).

GROSS PATHOLOGY

Sarcomata of the nerve-sheath are gray, firm growths, often leathery in consistency, which tend to infiltrate the surrounding structures (Fig. 2). The mass of the tumor is usually fairly well circumscribed.

The gross appearance resembles fibrosarcoma of fascial or periosteal origin. Cystic degeneration is not uncommon.

MICROSCOPIC PATHOLOGY AND HISTOGENESIS

The tissue observed in the earliest phase of tumor formation is mesenchymal in appearance. The cells are round or oval, and possess little or no visible cytoplasm (Fig. 3). They are irregular in size and are frequently multinucleated. These multinucleated cells are the forerunners of the large, malignant, giant cells, described as a criterion for the diagnosis of this type of sarcoma by Quick and Cutler, Jackson, and Herxheimer and Roth. Both the multinucleated and mononucleated cells are embedded in a pink-staining, homogeneous, intercellular substance. Many of the embryonic mesenchymal cells, with further growth, become spindle-shaped. Fibrospindle and fibroblastic cells, such as are found in fibrosarcomata elsewhere in the soft parts, are seen in Figure 4. The intercellular substance increases, and collagen fibrils replace the pink-staining ground substance in the more differentiated portions of the tumor. The fibrils become more conspicuous, and resemble those in the benign forms of nerve-sheath tumors. A tendency to palisading is often observed, and in some instances is very similar to that in perineural fibroblastomata. Whirls of fibrils with central areas of colloid-like material and pseudoclumping are some of the changes observed (Fig. 5). In some instances, mesenchyme, fibromyxoma, and fibroblastic sarcoma are intermingled, and suggest the transition of mesenchyme to fibromyxoma and to fibrosarcoma. Fibromyxomatous tissue is also observed in neurofibromata, undergoing malignant transformation, but without evidence of mesenchyme proliferation.

FIG. 2

P. N. 15065. Gross specimen of neurogenic sarcoma of the soft parts.

In summary, sarcoma of the nerve sheath resembles microscopically fibrosarcoma of the soft parts, differing in minor aspects from fibrosarcoma in the same way that benign neuromyxoma differs from simple fibroma.

PROGNOSIS AND TREATMENT

Treatment in the vast majority of cases consisted of excision. This operation was performed for the primary growth and for most of the

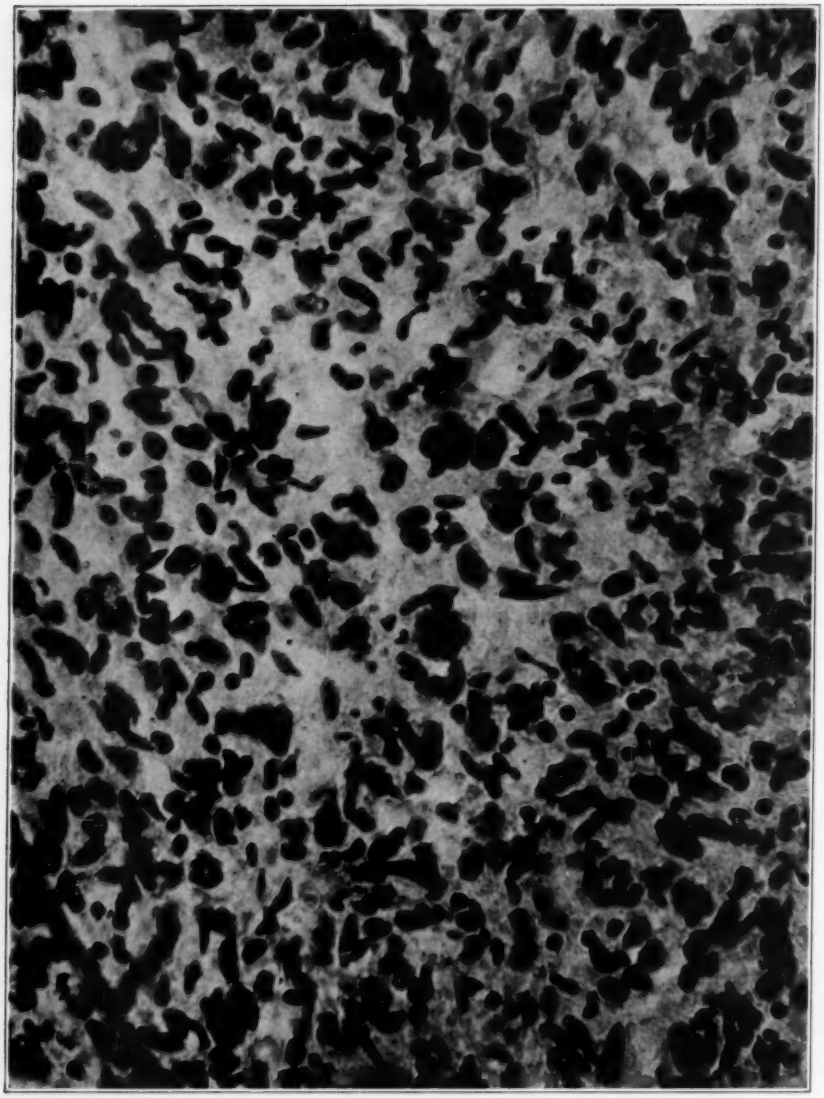

FIG. 3

P. N. 51382. Photomicrograph (high magnification) of a neurogenic sarcoma showing the earliest observable phase of tumor formation.

recurrences. Amputation was occasionally practised. Irradiation in this series proved of little value. Amputation is the treatment of choice when the sarcoma occurs along the deep nerve tracts of the extremities.

Of thirty-eight instances of single recurrences, nineteen, or 50 per cent., recurred within one year following operation. The maximum time interval for recurrence after initial treatment was eight years. In thirteen of the seventeen instances of multiple recurrences, there were two recurrences only (Table III).

The end results were traced in 115 of the 216 cases. Thirty-eight patients were living. Eighteen of these patients had lived less than five years; ten, from five to ten years; eight, from ten to twenty years; and two over twenty years. There were seventy-seven deaths. The duration of life was determined in forty-three cases; thirty-nine of these patients died within the first three years following operation or treatment.

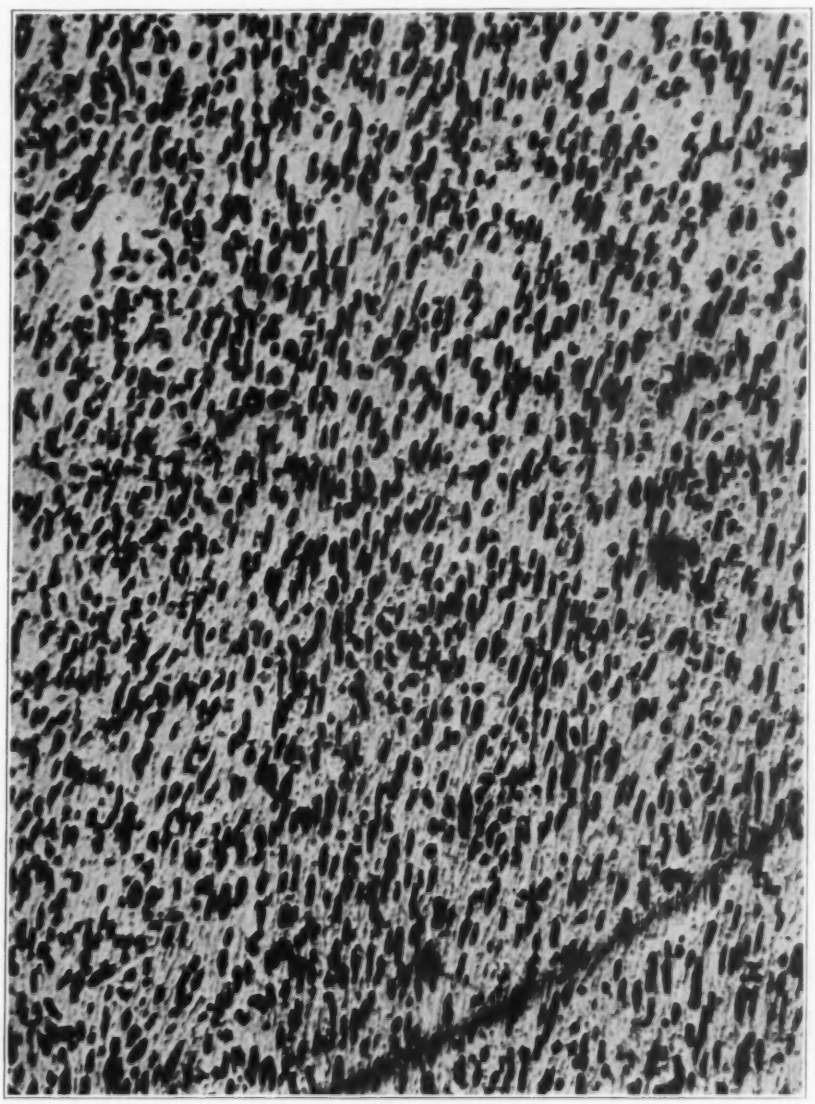

FIG. 4

P. N. 31775. Photomicrograph (medium magnification) of a neurogenic sarcoma showing fibrospindle and fibroblastic cells, and fine strands of collagen fibers in a more advanced stage of tumor formation. Compare with Fig. 3.

MALIGNANT TRANSFORMATION IN VON RECKLINGHAUSEN'S DISEASE

In the Surgical Pathological Laboratory there are thirty-six patients listed as having von Recklinghausen's disease. Malignant transformations had occurred in four instances, or in 11.1 per cent. Ten cases of sarcomatous transformations in von Recklinghausen's disease were listed under neurogenic sarcoma, but could not be included in this computation

FIG. 5

P. N. 48100. Photomicrograph (low magnification) of a neurogenic sarcoma in which the arrangement of tissue is similar to that observed in benign palisading neurinoma. The cellularity of the clump indicated by arrows from *a*, and the dusky nuclei are diagnostic of malignancy.

since the material was derived from clinics other than the Johns Hopkins Clinic. Thomson (1900) had collected eighteen instances of neurogenic sarcoma in a series of seventy-seven cases of von Recklinghausen's disease, an incidence of 23.4 per cent. Hosoi (1931) was able to collect sixty-five cases of sarcomatous transformation in von Recklinghausen's disease. He found that these changes occurred in 13 per cent. of the cases as compared with 12 per cent. reported by Garrè. In Hosoi's series there were thirty-nine males and twenty-four females. The youngest was fifteen; the oldest, seventy years; while 72 per cent. of the cases occurred in the third, fourth, and fifth decades.

In a total of fourteen cases from the Johns Hopkins Laboratory, in which such data were available, there were six males, five females, and three instances in which the sex was not reported. The ages at which transformation occurred varied from twenty to forty-five years, the average being thirty-four years.

FIG. 6

P. N. 26593. Gross specimen in a case of primary neurogenic sarcoma of the femur.

PRIMARY NERVE TUMORS OF BONE

Brooks and Lehman (1924) reported several cases of von Recklinghausen's disease in which neurofibromata arose from the periosteum or in bone. Peers (1934) described an intramedullary tumor of the ulna which histologically proved to be a malignant schwannoma (neurogenic sarcoma).

In the present series there are six instances of primary neurogenic sarcoma of the soft parts, which secondarily invaded bone by direct extension. The tibia, ulna, femur, and a rib were each involved once, and the tarsal bones were involved twice.

In two instances neurogenic sarcoma arose from the periosteum of bone, and invaded both the osseous and soft-part structures. Four cases consisted of primary central neurogenic sarcoma of bone. The source of origin is somewhat doubtful, but is thought to be the nerve fibers accompanying the blood vessels. These cases with bone involvement were all in the white race. There were two males and two females. The ages varied from nine to sixty-seven years. The femur was involved in

three instances and the coccyx in one. The roentgenographic changes were not unlike those of primary or secondary osteoclastic bone tumors (Fig. 6), the diagnosis being made only after biopsy. Treatment consisted of irradiation in two instances and amputation in four. In one of the cases treated by irradiation the patient died; in the other, the result could not be traced. Two of the patients treated by amputation were cured; one of the others died two years after amputation.

REFERENCES

Brooks, Barney, and Lehman, E. P.: The Bone Changes in Recklinghausen's Neurofibromatosis. Surg. Gynec. Obstet., XXXVIII, 587, 1924.

Cestan, R.: La Neurofibrosarcomatose. Revue Neurol., XI, 745, 1903.

Ewing, James: Neoplastic Diseases. A Treatise on Tumors. Ed. 3. Philadelphia, W. B. Saunders Co., 1928.

Garrè, C.: Ueber sekundär maligne Neurome. Beitr. z. Klin. Chir., IX, 465, 1892.

Herxheimer, G., und Roth, W.: Zum Studium der Recklinghausen'schen Neurofibromatose. Beitr. z. Path. Anat. u. z. Allg. Path., LVIII, 319, 1914.

Hosoi, Kiyoshi: Multiple Neurofibromatosis (von Recklinghausen's Disease) with Special Reference to Malignant Transformation. Arch. Surg., XXII, 258, 1931.

Jackson, A. H.: Three Cases of Multiple Neurofibromatosis with Malignant Degeneration. J. Nerv. and Ment. Diseases, LXXVIII, 581, 1933.

Krause, Fedor: Ueber maligne Neurome und das Vorkommen von Nervenfasern in denselben. Sammlung Klin. Vortrage (von Volkmann), Hefte 293, 294, Leipzig, 1887.

Peers, J. H.: Primary Intramedullary Neurogenic Sarcoma of the Ulna. Report of a Case. Am. J. Pathol., X, 811, 1934.

Quick, Douglas, and Cutler, Max: Neurogenic Sarcoma. A Clinical and Pathological Study. Ann. Surg., LXXXVI, 810, 1927.

von Recklinghausen, F.: Ueber die multiplen Fibrome der Haut und ihre Beziehung zu den multiplen Neuromen. (Festschr. zur Feier des fünfundzwanzigjährigen Bestehens des pathologischen Instituts zu Berlin, von Rudolf Virchow.) Berlin, August Hirschwald, 1882.

Stewart, F. W., and Copeland, M. M.: Neurogenic Sarcoma. Am. J. Cancer, XV, 1235, 1931.

Thomson, Alexis: On Neuroma and Neurofibromatosis. Edinburgh, Turnbull and Spears, 1900.

THE PATHOLOGICAL CHANGES IN RECURRENT DISLOCATION OF THE SHOULDER

A Report of Bankart's Operative Procedure *

BY FREDERIC C. BOST, M.D., AND VERNE T. INMAN, M.D.,
SAN FRANCISCO, CALIFORNIA

From the Department of Surgery, Division of Orthopaedic Surgery, University of California Medical School, San Francisco

The authors' interest in the pathological changes occurring in recurrent dislocation of the shoulder joint was stimulated by the paper of Bankart [2] who reported twenty-seven consecutive cases in which he had observed a detachment of the labrum glenoidale from the anterior aspect of the glenoid rim. He stated that this injury was the "essential" and the sole lesion in recurrent dislocation of the shoulder; in his opinion, the fibrocartilaginous structure of the detached labrum glenoidale precluded its reattachment to the glenoid rim, and thereby created a permanent weakness of the anterior part of the shoulder joint, predisposing the joint to recurrent dislocations.

Bankart believed that it is the specific character of the original dislocating trauma that determines the future tendency to recurrence. Whereas the ordinary anterior dislocation is produced by an abduction external-rotation leverage force, sheering off of the labrum glenoidale is produced by a forwardly directed force applied to the shoulder from behind.

It was Bankart's contention that the "essential lesion" has been overlooked, because the demonstration of the tear of the labrum glenoidale requires a special exposure of the shoulder joint. The operation which he performed is as follows (Fig. 1):

1. The shoulder joint is approached through a longitudinal incision which separates the deltoid and pectoralis major. This is facilitated by partial separation of the attachment of the pectoralis major from the humerus.

2. The tip of the coracoid process is detached and turned downward and medially with the attachments of the short head of the biceps tendon and coracobrachialis and pectoralis minor.

3. The humerus is rotated outward and the subscapularis tendon is divided near its insertion into the lesser tuberosity. The muscle is then drawn medially to expose completely the anterior shoulder joint.

4. The entire anterior aspect of the joint may be observed. If there is a tear through the capsule, the detached labrum glenoidale appears to be retracted with the capsule, either over the head of the humerus or over the

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 12, 1942.

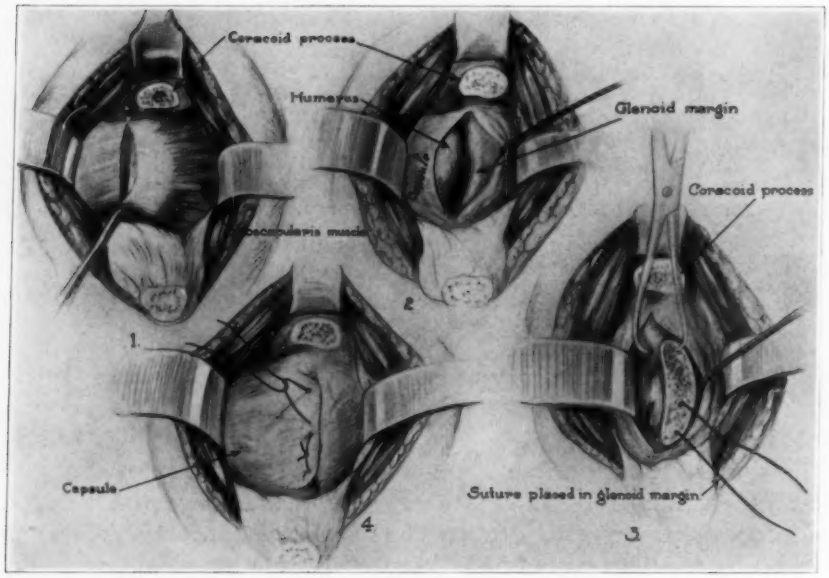

FIG. 1

Diagrammatic representation of the Bankart operation.

neck of the scapula. If the capsule is intact, it is incised parallel to the glenoid rim, exposing the detached labrum. After this procedure, the margin of the glenoid rim may be readily inspected. In Bankart's words, "In every case the anterior margin of the glenoid cavity will be found to be smooth, rounded, and free from any attachments, and a blunt instrument can be passed freely inwards over the bare bone on the front of the neck of the scapula".

5. The glenoid rim is raised with a chisel and the free edge of the capsule, with or without the labrum glenoidale, is sutured to the bony margin.

6. The divided structures are replaced, and the arm is bandaged to the side for four weeks.

In Bankart's experience, the repair of this "typical", "uncomplicated", "essential" lesion has invariably prevented recurrence of the dislocation.

These observations seem to refute much that had been previously recorded concerning the etiology of recurrent dislocations. Although much confusion surrounds the subject, it was difficult to reject summarily the many careful observations and studies of other workers. For this reason the present investigation was undertaken.

Since September 1938, the authors have used Bankart's procedure in ten consecutive cases of recurrent dislocation of the shoulder. In every instance the tear of the labrum glenoidale as described by Bankart was found, and unquestionably this lesion is of primary significance in recurrent dislocation. In each of these ten shoulders, however, there were

additional pathological findings,—namely, erosion of the ventral glenoid rim and roentgenographic evidence of a defect in the posterolateral portion of the head of the humerus.

ANATOMY OF THE SHOULDER JOINT

An appreciation of the pathological changes of recurrent dislocation must be based upon an accurate conception of the anatomy of the shoulder joint. The unsatisfactory descriptions in standard textbooks of anatomy led to the study of a number of especially prepared dissections (Figs. 2 and 3). The hemispherical head of the humerus articulates with the shallow concavity of the glenoid fossa, but scarcely one-quarter of its articular surface is in contact with the fossa at any time. The fossa is pear-shaped in outline,—being narrower above than below. Its rim presents a shallow notch in its anterosuperior part, through which the upper tendinous fibers of the subscapularis play, and this notch indicates on the bone specimen the position of the subscapular bursa. The anteroinferior margin is slightly elevated above the level of the remaining portions of the rim, giving added support to the humeral head at this point. The glenoid cavity is very shallow, but, in the fresh state, it is deepened and enlarged by the labrum glenoidale and by the fact that its cartilaginous lining is thinnest centrally.

The labrum glenoidale is a ring of dense fibrocartilaginous tissue attached to the margin of the glenoid. This structure is triangular in section, one side being applied to the surface of the glenoid rim, overlapping the articular cartilage to which it is loosely fastened. Its firmest attachment skirts the outer edge of the glenoid rim, where it is bound down by dense fibrous tissue. The other two surfaces of the labrum are free. One surface is in contact with the head of the humerus and the other with the capsule of the joint. The capsule extends, however, for several millimeters beyond the labrum before being reflected onto the glenoid rim, thus forming a narrow furrow which lies between the capsule and the labrum.

Antero-inferiorly there is a definite and constant thickening of the subsynovial connective tissue of the capsule, extending from the edge of the labrum to the neck of the humerus, which at this level obliterates the furrow. This structure is the inferior glenohumeral ligament. A similar thickening in the capsule is found anterosuperiorly, parallel to the biceps tendon which extends from the glenoid rim toward the lesser tuberosity. This structure is the superior glenohumeral ligament. The opening of the subscapular bursa lies directly below this ligament and forms the upper margin of the bursal aperture. The synovial fibrous capsule of the shoulder joint is thin anteriorly, and can be separated from the subscapularis tendon on the scapular side; but, as it is followed laterally, it blends intimately with the tendon.

The manner in which the subscapular bursa opens into the shoulder joint is subject to minor variations. The upper margin of its aperture is

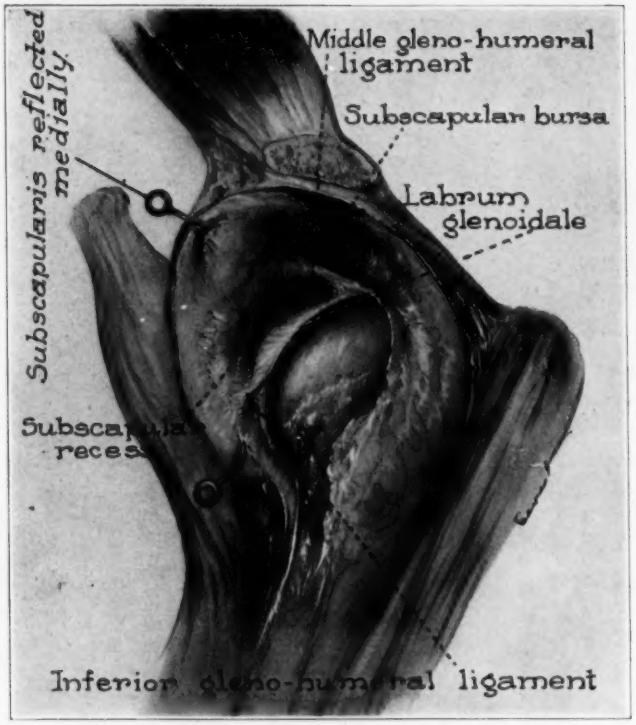

FIG. 2

Anterior view of the shoulder joint. The subscapularis tendon, together with the capsule, has been cut and reflected medially, exposing the openings of the subscapular bursa and subscapular recess.

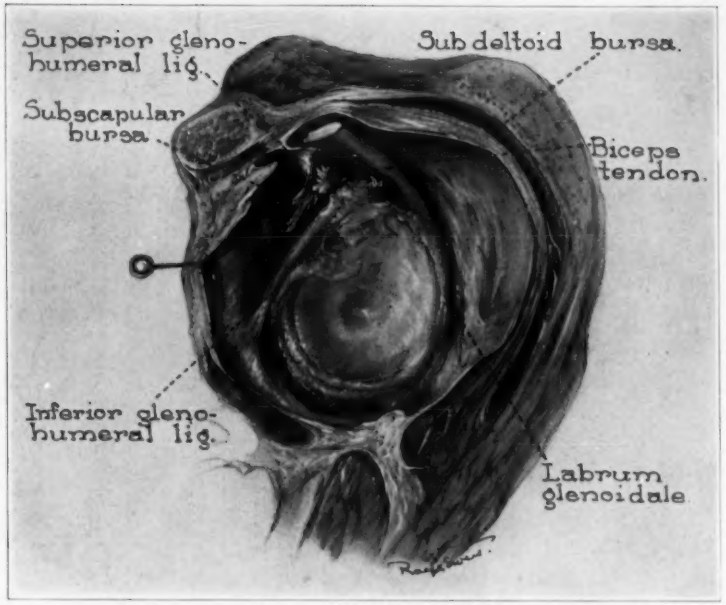

FIG. 3

Interior view of shoulder joint showing the essential structures. In this specimen the opening of the subscapular bursa is large and the middle glenohumeral ligament is absent. Note particularly how the inferior glenohumeral ligament anchors the antero-inferior portion of the capsule to the labrum glenoidale.

marked by the superior glenohumeral ligament, and is constant in its anatomical arrangement. The lower border of the aperture is, however, more variable. When the bursal aperture is small, it is bounded below by a subsynovial capsular thickening, known as the middle glenohumeral ligament, and the furrow between the labrum glenoidale and the capsule extending down to the inferior ligament may, in some cases, reach a depth of from twelve to fifteen millimeters, thus forming a recess opposite the lower fibers of the subscapularis muscle, and functionally supplementing the true bursa. When the middle glenohumeral ligament is absent or insignificant, the aperture is larger and may reach the inferior glenohumeral ligament which then constitutes its inferior boundary.

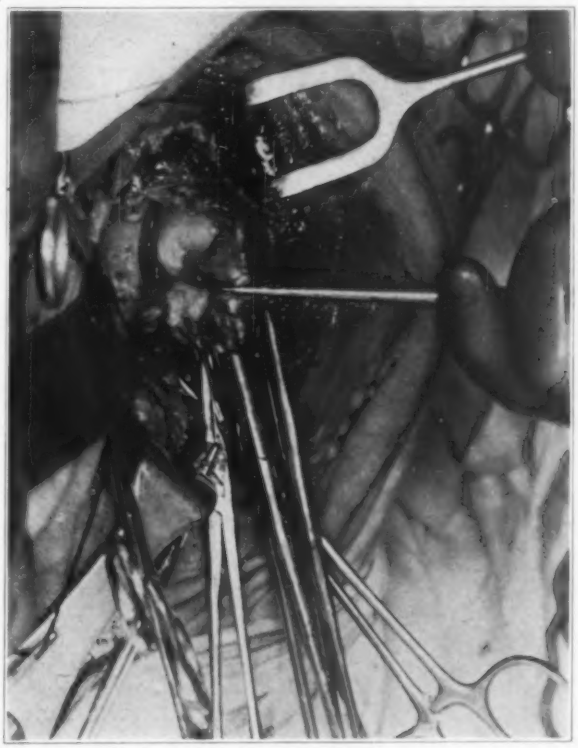

FIG. 4

Case 5. Exposure of shoulder joint at operation. The subscapularis muscle has been reflected medially. The capsule, torn at the glenoid rim, has been reflected laterally. The labrum glenoidale is markedly frayed. The eburnated, eroded, and flattened glenoid rim is evident.

The subscapular bursa and the frequent occurrence of an additional subscapular recess below the aperture of the subscapular bursa prevent any intimate attachment between the capsule and the labrum glenoidale, except through the medium of the glenohumeral ligaments. This anatomical arrangement deprives the labrum of any capsular support on the anterior portion.

PATHOLOGICAL FINDINGS AT OPERATION

In each of the ten cases, the subscapularis was readily identified at operation, but no abnormality was noted. In several cases it was obvious that an anterior dislocation was present. In one instance, as the tendon of the subscapularis was followed laterally, a number of small rice bodies were found lying below the lesser tuberosity, medial to, but not connected with, the biceps tendon.

FIG. 5-A

FIG. 5-B

Fig. 5-A: Case 8. External rotation. The head of the humerus appears to be normal.
Fig. 5-B: Internal rotation. The posterolateral defect appears as a flattening and irregularity on the superolateral aspect of the head.

FIG. 6-A

FIG. 6-B

Fig. 6-A: Case 5. External rotation. The contour of the head of the humerus appears to be normal. The location of the defect is indicated by an area of increased density.

Fig. 6-B: Internal rotation. The defect is apparent with sharp vertical walls. A loose fragment lies at the base of the defect.

FIG. 7-A

Case 6. External rotation. The posterolateral defect in the humeral head is not apparent.

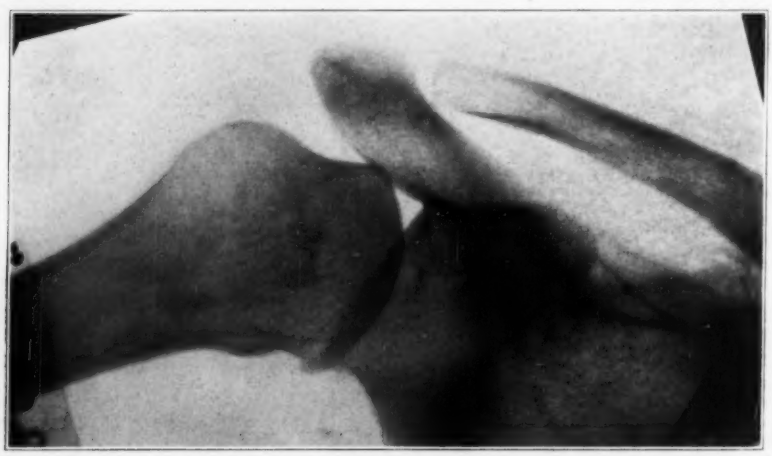

FIG. 7-B

Internal rotation. The posterolateral defect appears as a notching of the superior articular surface of the head.

Incision of the subscapularis tendon near its insertion into the lesser tubercle of the humerus requires extreme care. While the more tendinous superior portion can be readily identified, more inferiorly the musculotendinous fibers spread out to become attached below the tubercle for a distance of from two to three centimeters; but before the subscapularis reaches the humerus, it inserts directly into and blends with the capsule of the shoulder joint. For this reason the tendon should be incised two centimeters from its bony attachment. Even then the intimate blending of tendon and capsule makes it difficult to separate the two. In seven of

FIG. 8

Case 5. Irregularity of the glenoid rim with proliferation of new bone about the scapular neck is demonstrated. The dense area in the head indicates the posterolateral defect.

these cases, the capsule was incised as the tendon was cut. When the dislocation was not already present, incision of the tendon released the head of the humerus, so that it rotated externally and dislocated.

As the subscapularis tendon was reflected medially, it could be separated from the capsule, though in some cases sharp dissection was necessary. Once the glenoid rim was reached, it was easy to retract the subscapularis medially, owing to the absence of any attachment to the scapular neck.

Reflection of the subscapularis allowed inspection of the capsule of the anterior portion of the shoulder joint and of the subscapular bursa. The superficial wall of the bursa was reflected with the subscapularis on all but three occasions, allowing direct vision of the joint through the bursal opening.

In six patients, vertical capsule tears were evident at or near the glenoid rim. Some of these openings extended from the superior to the inferior poles of the glenoid cavity; while, in the three instances in which the subscapularis bursa was not opened, the rents were from one to two centimeters in length, and were located in the inferior portion of the capsule. In addition to these tears, redundant capsular pockets lay

inferiorly to the glenoid rim in three patients. Through these capsular openings, the glenoid rim was seen in each case to be denuded of the fibrocartilaginous labrum. In four, the capsule and the labrum were avulsed in mass from the entire extent of the antero-inferior glenoid margin and lay together, collarlike, over the head of the humerus. In two others, the labrum was so split and frayed that it was hardly distinguishable, and the glenoid rim was denuded. The proximal portion of the capsule medial to the rents was elevated from the neck of the scapula. In four patients, no rent in the anterior capsule was detected, but a detachment of the antero-inferior capsule and labrum was present. This was readily demonstrated by passing a Kocher dissector deep into the capsule over the bare glenoid rim and along the scapular neck. In these four cases, the capsule was incised vertically at the glenoid rim. In two, the labrum glenoidale was retracted medially over the scapular neck; while in the other two it was found detached and lying just lateral to the glenoid rim. As in the first group of six cases, the detachment of the labrum glenoidale was wide and virtually bipolar in extent.

Other abnormalities noted within the capsule were the presence of small rice bodies in two shoulders and, in Case 5, a loose, cartilaginous body, 2.5 by 1.0 by 0.5 centimeters in size, which was present anteriorly. Although the origin of this loose body was not definitely proved, it was thought to have originated from the posterolateral defect of the humeral head described later (Fig. 4).

Glenoid Rim

In all of the cases the glenoid rim was abnormal in appearance. The changes consisted of erosions, irregular disintegration of the cartilage, and rounding off of the bony rim. The edges were eburnated, irregular, and a bony overgrowth was present in some instances. In Case 3 fibrillation of the cartilage and eburnation were extensive, and the presence of small loose rice bodies was a prominent feature. In Case 5 a large irregular defect on the antero-inferior rim suggested an old fracture of the bony margin. This case was associated with a large intracapsular cartilaginous loose body, described above, which did not fit, nor is it believed to have had origin from this defect. In Cases 6 and 10, extensive flattening, eburnation, and cartilaginous erosion of the antero-inferior portion of the glenoid cavity were very evident. In Case 10 the glenoid cavity was extremely narrow in its lower third, suggesting the loss of bone substance.

In several instances the loss of the normal bluish-white appearance of the glenoid surface evidenced the presence of attritional changes in the cartilage.

The Head of the Humerus

Two patients showed attritional changes in the cartilage of the head of the humerus, with some fibrillation on the anterior margin. One patient had erosive changes about the lesser tuberosity.

FIG. 9

Anterior and posterior views of the humeral head. Note the typical defect which occupies the posterior articulating surface of the humeral head.

The anterior approach to the joint does not permit visualization of the posterior aspect of the humeral head, and posterior exposure of the humeral defect was not employed.

Roentgenographic Findings

In every instance roentgenographic studies of the patients with recurrent dislocation showed the presence of an unquestionable defect in the posterior aspect of the head of the humerus. These changes varied from easily identified cystic areas, through flattening and irregularity, to a marked notching, involving as much as one-third of the posterior portion of the head of the humerus (Figs. 5-A, 5-B, 6-A, 6-B, 7-A, and 7-B).

In addition to the defects in the humeral head, four patients presented roentgenographic evidence of the stubbing, lipping, and bone proliferation of the antero-inferior glenoid margin (Fig. 8). These changes were verified later at operation.

DISCUSSION

A detailed account of the findings has been presented above, because of the conflicting ideas concerning the essential pathological changes of recurrent dislocation of the shoulder. Bankart, alone, recognized the constant presence and great significance of the tear of the labrum glenoidale.

All of the other conditions encountered in these patients have been described and discussed by many others. Neither these observations nor the authors' experiences substantiate Bankart's opinion that the tear of the labrum is the sole lesion in recurrent dislocation. Nevertheless, in

the authors' opinion, his observations form the key to the etiology of this condition.

At various times pathological changes in all of the structures which make up the shoulder have been considered responsible for the tendency toward redislocation. Defects in the posterolateral portion of the head of the humerus have been described from examinations of both anatomical specimens and portions of the heads resected at operation.[4, 9, 13, 14, 17, 23, 28, 29, 30, 31, 32] These defects, ranging from a mere irregularity to excavation of as much as one-third of the posterior head, have been attributed to compression fracture or pressure erosion (Fig. 9). Accompanying these changes either fracture or erosion of the anterior glenoid margin has been noted.[13] The accurate fitting together of the posterior defect and the anterior rim of the glenoid (Fig. 10) has been mentioned frequently since it was first reported by Löbker in 1882. Inasmuch as special projections are needed to disclose their presence, roentgenographic recognition of such defects has been slow, though they were first noted by Perthes in 1906, and by Schultze in 1914. Hill and Sachs recently refocused attention upon the demonstration of these changes by roentgenographic methods. They pointed out that the defect on the posterolateral portion of the humeral head is not disclosed by the ordinary anteroposterior view with the arm in external rotation. Visualization of the involved aspect of the head requires an anteroposterior projection, taken with the arm in marked internal rotation, a position which presents the profile of the posterolateral aspect of the head. Such roentgenograms show changes varying from cystic areas and slight flattening of the contour of the head of the humerus to excavations which may include almost a third of the posterior articulating surface of the head. The largest of these defects or excavations are characterized by a notched-out area with a sharp vertical border which lies in close relation to the greater tuberosity.

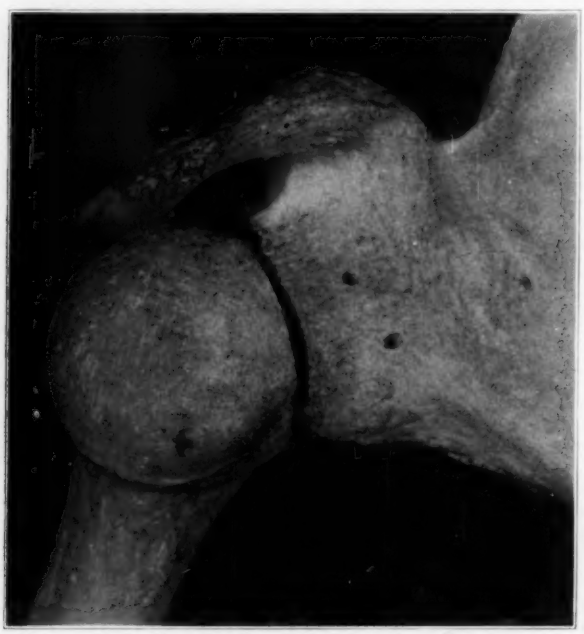

FIG. 10

Photograph of the externally rotated humerus articulated with the scapula. Note how accurately the medial edge of the humeral defect fits the anterior glenoid rim.

FIG. 11

Photograph of the externally rotated and slightly abducted humerus, articulated with the scapula. The defect on the humeral head lies opposite the glenoid fossa and the anterior glenoid rim tends to fall into the defect, causing the humerus to slip forward.

A great deal has been written regarding the anterior capsule and the subscapularis. Since the dislocations occur through the antero-inferior part of the joint, Thomas believed that there was an anterior herniation of the capsule following dislocation. He reviewed the literature and discussed in detail the reports concerning capsule tears, relaxation of the capsule, and stripping of the capsule from the glenoid margin. Stimson, and Burrell and Lovett likewise discussed the findings of earlier investigators. Since these discussions, the chief additions have been made by Gallie and LeMesurier who emphasized the importance of the tearing of the capsule and the inferior glenohumeral ligament from the glenoid rim, and by Cotton and Morrison who pointed out the deficiency of the anterior capsule of the shoulder joint. Reich and Henderson, among others, questioned the sufficiency of the subscapularis, although no exact description of this condition has been given. In 1891, Sick, quoted by Thomas [29] reported a case in which ". . . the glenoid cartilage was destroyed from the lower end of the cavity up to the insertion of the long head of the biceps". Thomas [29], after experiments on cadavera, stated that a disturbance of the glenoid cartilage might be expected. Except for Bankart's report [2] however, no further mention of the labrum glenoidale has been found in the literature. Thomas, in his discussion of the operative findings through a posterior axillary approach[31], reported that by palpation "a small piece of bone may be detected in the antero-inferior part of the joint, loosely attached by a fibrous pedicle or

imbedded in the capsule"; but he did not identify this as the labrum glenoidale.

Of all the investigators, Thomas [31] and Reich appear to have been the first to attempt an integration of the pathological findings in order to explain the etiology of recurrent dislocation. Reich, from his study of cadavera and macerated skeletons, established the coexistence of a group of changes contributing to dislocation of the shoulder. These, in his opinion, consisted of the bone defects and a functional deficiency in the subscapularis with a subscapularis bursitis.

Finally Bankart, by pointing out the constant occurrence of the tear of the labrum glenoidale, made it possible for the first time to link together the complete picture of the pathological changes attendant upon recurrent dislocation.

Adding to these studies, the authors' observations lead to the conclusion that the pathological changes are:

1. Detachment of the labrum glenoidale and the anterior capsule of the shoulder joint.
2. A defect in the posterolateral portion of the head of the humerus.
3. Erosion or fracture of the glenoid rim.

This concept of the combined pathological changes in recurrent dislocation permits an understanding of the etiology of this condition.

The Mechanism of Production of Recurrent Dislocation

A great disparity exists in the description of various authors as to the precise mechanism of anterior dislocation of the shoulder. This is understandable, because the combination of pathological changes exhibited by these patients has not been appreciated.

As a result of the present studies, the authors feel that the essential mechanism is one in which the head of the humerus is driven forward onto the glenoid rim by a force applied either directly to the shoulder, or indirectly through leverage of the arm by abduction in internal rotation or by hyperextension. At this stage there must be initial tearing or stretching of the anterior capsular attachments. As the head is carried farther forward, the arm must pass into a position of abduction and external rotation to bring the posterosuperior aspect of the humeral head into contact with the edge of the glenoid fossa. The extent of injury to the labrum glenoidale and to the lip of the glenoid fossa, together with the production of a compression or sheering fracture of the head of the humerus, will depend upon the force with which the head is thrust against the anterior glenoid lip. If this force is great, the labrum is wiped from its attachments, and the sharp edge of the glenoid rim digs into the posterior aspect of the head of the humerus, depressing or scooping out a bone defect, with or without chipping of the glenoid lip. This is conceived to be the initial damage, and the ease with which redislocation occurs depends upon the extent of this initial injury.

A recurrent dislocating shoulder is, therefore, one which has sustained

an avulsion of the labrum glenoidale and capsular anchorage, with stubbing of the glenoid rim and some destruction of the posterosuperior aspect of the articulating surface of the humeral head. In such cases the head is supported only by the shallow concavity of the glenoid fossa, because the detached labrum and capsule offer no resistance to the dislocating force. When the arm is abducted and externally rotated—the position most likely to lead to redislocation—the defect in the humeral head lies opposite the glenoid fossa, and the normal locking effect of the convex surface of the head is lost. Should the structures attached to the anterior glenoid rim be avulsed, there is nothing to prevent the head of the humerus from sliding forward and dislocating (Fig. 11).

If the shoulder is dislocated habitually, secondary changes appear attendant upon the development of a traumatic arthritis. These changes are proliferation of bone about the scapular neck, eburnation of the glenoid rim, production of loose bodies, synovial thickening, and cartilaginous disintegration.

Report of Operative Results

The great variety of operations designed to check the tendency toward a recurrence of the dislocation indicates a general lack of understanding in regard to the causes of the disorder. It is not the authors' intention to discuss or compare the various operative procedures used in recurrent dislocation. It may be pointed out, however, that a proper conception of the etiology and pathological changes of this condition should lead to an improvement in the methods of operative repair to be employed for its relief.

The operation used by Bankart has proved to be an excellent one in the experience of its originator. It is a satisfactory procedure in that it allows exposure of the lesion primarily responsible for the dislocation. It must be understood that actual replacement of the labrum glenoidale is not always possible, for this structure is sometimes frayed and relatively non-existent. It is, however, possible to fasten the capsule securely to the glenoid rim from which it has been stripped.

The authors' limited experience indicates that the use of this operation has certain disadvantages,—namely, the technical difficulties of suturing the capsule and labrum to the deeply placed glenoid rim, and the relatively poor and thinned-out capsular structure sometimes found at the site for resuture. This latter condition has been circumvented by suturing some of the posterior surface of the subscapularis to the glenoid rim.

Eight of the ten patients (Table I) have been followed for from eighteen months to over three years,—a sufficient time to permit an evaluation of results. Seven patients have had no recurrences, although one of them was observed for only seven months. At the end of that time, however, he had a full range of motion and had engaged in competitive sports. All of these patients were muscular males engaged in the most vigorous occupations, and all have reported excellent function of the

TABLE I

RÉSUMÉ OF TEN CASES

Case No.	Sex and Age at Operation	Occupation	Initial Trauma	Date of Operation	Operative Findings			Roentgenographic Findings		Final Result
					Labrum Glenoidale	Glenoid Rim	Capsule	Humeral Head	Glenoid	
1 E. A.	Male 35	Fireman	1937 Fall; sudden forced abduction.	Sept. 14, 1938	Complete anteroinferior detachment; lateral displacement.	Roughened; eroded; eburnated.	Torn at glenoid rim.	Flattened posterosuperior portion.	Negative	39 months postoperative; no recurrence; no restriction of motion. Hard manual work.
2 W. B.	Male 16	Student	1936 Tackled in football.	Nov. 22, 1938	Complete anteroinferior lip detached; lateral displacement.	Eburnated; cartilage eroded; lipping.	Torn at glenoid rim.	Cystic changes; flattened and irregular posterosuperior portion.	Negative	37 months postoperative; no recurrence; no restriction of motion. All types of heavy labor.
3 J. L. Right	Male 36	Construction worker	1929 Scuffling.	June 16, 1939	Complete anteroinferior detachment; deflected laterally.	Eroded; cartilage eroded; proliferation.	Torn at glenoid rim; rice bodies present.	Irregular; flattened; defect of ⅓ of posterior head with loose fragments and proliferation; cystic changes.	Lipping and proliferation; question of fracture of rim.	30 months postoperative; no recurrence; no restriction of motion. Heavy labor and ship riveting.
4 P. I.	Male 22	Student	1937 Wrestling, extreme abduction and flexion.	July 11, 1939	Complete anteroinferior detachment; medial displacement.	Eburnated; cartilage eroded.	Not torn at rim; rice bodies medial to biceps tendon; mild synovitis.	Cystic change in posterolateral portion.	Negative	7 months after operation; no recurrence. Had played college basketball.

5 J. L. Left	Same patient as Case 3	Construction worker	1930 Cranking truck.	Oct. 11, 1939	Complete antero-inferior detachment with marked fraying.	Eburnated; cartilage eroded; flattened; large loose body.	Torn at glenoid rim; marked synovitis; loose body.	Large defect; flattened.	Marked proliferation; question of fracture.	26 months postoperative; no recurrence; no restriction of motion. Heavy labor and ship riveting.
6 J. R.	Male 26	Elevator operator (Epileptic)	1933 Scuffling.	Oct. 16, 1939	Complete antero-inferior detachment with fraying; lateral displacement.	Eburnated; flattened; scarring of cartilage.	Torn at glenoid rim.	Large defect scooped out of posterolateral margin; ⅛ eroded.	Negative	26 months postoperative; recurrence 3 weeks after operation and repeatedly thereafter, due to inadequate repair and immobilization.
7 J. B.	Male 18	Student	1938 Abduction; external rotation; football injury.	May 2, 1940	Complete antero-inferior detachment; medial displacement.	Eburnated; roughened.	Ripped from rim; no rent.	Flattened; irregular with question of a detached portion.	Negative	20 months postoperative; no recurrence; no restriction of motion. Shipyard worker.
8 H. B.	Male 20	Student	1937 Football line play.	July 14, 1940	Complete antero-inferior detachment; lateral displacement.	Eburnated; rounded; irregular.	Ripped from glenoid; no rent.	Flattened and irregular posterolateral portion.	Lipping and sclerosis of rim.	17 months postoperative; no recurrence; no restriction of motion. Machinist; heavy work.
9 R. H.	Male 21	Student	1936 Skiing; abduction; external rotation.	May 21, 1941	Complete antero-inferior detachment; lateral displacement.	Roughened with lipping.	Stripped from scapular neck; no rent.	Concavity of ⅕ of posterolateral surface; sclerosis.	Negative	7 months postoperative; no recurrence; no restriction of motion. Heavy machine work.
10 R. B.	Male 40	Forester	1919 Slipped and fell.	Nov. 20, 1941	Complete antero-inferior detachment; lateral displacement.	Eroded; lipping.	Rent in capsule.	Cystic area; flattened; irregular.	Lipping	6 weeks postoperative; partial immobilization.

shoulder. The eighth patient, an epileptic, has had repeated dislocations, beginning three weeks after operation. This failure can be attributed to the unsatisfactory repair. It is interesting to note that the head of the humerus showed a large defect. Of the remaining two patients, one is doing heavy machine work, seven months after operation. The other was operated upon only six weeks ago.

CONCLUSIONS AND SUMMARY

The principle purpose of this paper has been to extend the observations of Bankart on recurrent dislocation of the shoulder joint and to present a triad of pathological findings which the authors consider essential to the etiology of this condition. This triad consists of:

1. Detachment of the labrum glenoidale and the anterior capsule of the shoulder joint.
2. A defect in the posterolateral portion of the head of the humerus.
3. Erosion or fracture of the glenoid rim.

The findings indicate that recurrent dislocation of the shoulder is likely to be associated with far more extensive damage to the joint than has been heretofore disclosed. The complexities of the findings necessitate not only a more complete study, but also special examinations of the individual case before an accurate prognosis can be arrived at and rational therapy instituted. The surgical procedure adopted in the treatment of these cases must be governed by a full appreciation of the extent of the underlying pathology, if a successful outcome is to be anticipated.

The authors wish to express their appreciation to John B. deC. M. Saunders, M.D., Professor of Anatomy, University of California Medical School, for his many kindnesses and helpful suggestions in the preparation of this manuscript.

REFERENCES

1. Bankart, A. S. B.: Recurrent or Habitual Dislocation of the Shoulder-Joint. British Med. J., II, 1132, 1923.
2. Bankart, A. S. B.: The Pathology and Treatment of Recurrent Dislocation of the Shoulder-Joint. British J. Surg., XXVI, 23, 1938.
3. Burnet, B. S.: Recurrent Anterior Dislocation of the Shoulder. Report of Eleven Cases Operated on by the Method of Roberts. J. Bone and Joint Surg., XX, 926, Oct. 1938.
4. Burrell, H. L., and Lovett, R. W.: Habitual or Recurrent Dislocation of the Shoulder. Am. J. Med. Sciences, CXIV, 166, 1897.
5. Carrell, W. B.: Habitual Dislocation of the Shoulder. J. Am. Med. Assn., LXXXIX, 948, 1927.
6. Cotton, F. J., and Morrison, G. M.: Recurrent Dislocation of the Shoulder. New England J. Med., CCX, 1070, 1934.
7. Gallie, W. E.: Dislocations. New England J. Med., CCXIII, 91, 1935.
8. Gallie, W. E., and LeMesurier, A. B.: An Operation for the Relief of Recurring Dislocation of the Shoulder. Trans. Am. Surg. Assn., XLV, 392, 1927.
9. Gray, C. H.: Recurrent Dislocation of the Shoulder-Joint. Internat. Abstr. Surg., LXIX, 529, 1939.
10. Groves, E. W. Hey: Recurrent Dislocation of the Shoulder. A Plea for a Simple Operation. British J. Surg., XXVI, 375, 1938.

11. Henderson, M. S.: Recurrent or Habitual Dislocation of the Shoulder. J. Am. Med. Assn., LXX, 1, 1918.
12. Henderson, M. S.: Habitual or Recurrent Dislocation of the Shoulder. Surg. Gynec. Obstet., XXXIII, 1, 1921.
13. Henderson, M. S.: Habitual Dislocation of the Shoulder. J. Am. Med. Assn., XCV, 1653, 1930.
14. Hill, H. A., and Sachs, M. D.: The Grooved Defect of the Humeral Head. A Frequently Unrecognized Complication of Dislocations of the Shoulder Joint. Radiology, XXXV, 690, 1940.
15. Hobart, M. H.: Recurrent Dislocation of the Shoulder. Nicola Operation. With Report of Cases. J. Bone and Joint Surg., XV, 733, July 1933.
16. Hobart, M. H.: The Hobart Operation. A New Combination Operation for Recurrent Dislocation of the Shoulder. J. Bone and Joint Surg., XVII, 1001, Oct. 1935.
17. Löbker, Karl: Einige Präparate von habitueller Schulterluxation. (Verhandlungen der Deutschen Gesellschaft für Chirurgie, Fünfzehnter Congress, 210, 1886.) Arch. f. Klin. Chir., XXXIV, 658, 1886.
18. Nicola, Toufick: Recurrent Anterior Dislocation of the Shoulder: A New Operation. J. Bone and Joint Surg., XI, 128, Jan. 1929.
19. Nicola, Toufick: Recurrent Dislocation of the Shoulder: Its Treatment by Transplantation of the Long Head of the Biceps. Am. J. Surg., VI, 815, 1929.
20. Nicola, Toufick: Recurrent Dislocation of the Shoulder. J. Bone and Joint Surg., XVI, 663, July 1934.
21. Norton, W. I.; Mortensen, O. A.; and Sullivan, W. E.: Morphological Changes Accompanying Fixation of the Biceps Tendon (Nicola Operation). An Experimental Study of Animals. J. Bone and Joint Surg., XXI, 127, Jan. 1939.
22. Perthes, Georg: Über Operationen bei habitueller Schulterluxation. Deutsche Ztschr. f. Chir., LXXXV, 199, 1906.
23. Reich, R. S.: Traumatic Dislocation of the Shoulder. J. Bone and Joint Surg., XIV, 73, Jan. 1932.
24. Roberts, P. W.: An Operation for Recurrent Dislocation of the Shoulder. J. Bone and Joint Surg., XV, 233, Jan. 1933.
25. Schultze, E. O. P.: Die habituellen Schulterluxationen. Klinischer und experimenteller Beitrag. Arch. f. Klin. Chir., CIV, 138, 1914.
26. Sick: *Quoted by* T. T. Thomas[29].
27. Speed, Kellogg: Recurrent Anterior Dislocation at the Shoulder: Operative Cure by Bone Graft. Surg. Gynec. Obstet., XLIV, 468, 1927.
28. Stimson, L. A.: A Practical Treatise on Fractures and Dislocations. Ed. 4, p. 597. Philadelphia, Lea Bros. & Co., 1905.
29. Thomas, T. T.: Habitual or Recurrent Anterior Dislocation of the Shoulder. I. Etiology and Pathology; II. Treatment. Am. J. Med. Sciences, CXXXVII, 229 and 367, 1909.
30. Thomas, T. T.: Recurrent Anterior Dislocation of the Shoulder. With a Report of Three Cases Treated by Capsulorrhaphy through an Axillary Incision. J. Am. Med. Assn., LIV, 834, 1910.
31. Thomas, T. T.: Habitual or Recurrent Dislocation of the Shoulder. Eighteen Shoulders Operated On in Sixteen Patients. A New Axillary Operation. Surg. Gynec. Obstet., XVIII, 107, 1914.
32. Thomas, T. T.: Recurrent Dislocation of the Shoulder Joint. J. Am. Med. Assn., LXXXV, 1202, 1925.

ANTERIOR DISLOCATION OF THE SHOULDER

The Rôle of the Articular Capsule

BY TOUFICK NICOLA, M.D., MONTCLAIR, NEW JERSEY

From the Division of Orthopaedic Surgery, Mountainside Hospital, Montclair

This report is limited to the rôle of the capsule in the dislocated shoulder, and to the treatment of acute and recurrent dislocations. Complicated and old unreduced dislocations, and nerve injuries are not included.

MECHANISM OF PRODUCTION OF ANTERIOR DISLOCATION

In the majority of cases, anterior dislocations of the shoulder are produced by a fall or blow upon the abducted arm. If the abduction force continues to produce hyperabduction, the head of the humerus is forced down, so that it rests upon the inferior portion of the capsule. At this point a traction force comes into play, and the head of the humerus begins to lift out of the glenoid cavity. This is due to the concavity of the glenoid cavity and to the abducting force. The capsule then begins to separate from the neck of the humerus when the humerus is at 105 degrees of abduction in relation to the glenoid cavity. By further abduction and outward rotation, the capsule tears away from the neck of the humerus to such a degree that the head of the humerus is allowed to dislocate. If, on the other hand, a force of impaction is added, with the humerus in 105 degrees of abduction, the labrum glenoidale together with the articular capsule attached to the neck of the scapula are torn, thus allowing the head of the humerus to dislocate.

In none of the cases studied was the capsule torn near the center of the inferior portion, where it is anatomically thinnest.

This report is based on a study of eighty dislocated shoulders,—five fresh acute dislocations, fifty dislocations produced upon fresh cadavera, and twenty-five consecutive recurrent dislocations.

Acute Dislocations

The five patients operated upon for acute dislocation ranged from eighteen to forty-eight years of age.

Case 1. A high-school student, aged eighteen, fell while playing football. When giving his history, he was quite definite that his shoulder dislocated after he fell on his elbow with his arm out from the side of his body. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the scapula for about two inches. The labrum glenoidale was also ruptured. In this case the force was one of abduction plus impaction.

Case 2. A prize fighter, aged twenty, threw a punch with his left hand which struck the side of the head of his opponent who was coming in fast to force the fight. At operation the capsule was found to have been torn away from the anterior and inferior aspects

of the neck of the humerus up to the subscapularis tendon. In this case the force was one of hyperabduction.

CASE 3. A school teacher, aged thirty-three, had her shoulder stretched under anaesthesia to increase motion for so-called chronic adhesive bursitis or periarthritis. After stretching, which was accompanied by the usual sounds, the arm was placed in hyperabduction, with the hand held to the head of the bed. The next day, the patient complained of severe pain. A roentgenogram showed a subcoracoid dislocation. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the humerus up to the subscapularis tendon.

CASE 4. A housewife, aged forty, was admitted to the Hospital for a stretching to increase motion at the shoulder for so-called chronic adhesive bursitis or periarthritis. Before the shoulder was stretched, the joint was exposed down to the capsule, the arm was then abducted, and it was noted that at 80 degrees the capsule began to tear away from the neck of the humerus, with the usual sounds. As abduction was continued, the capsule tore away from the anterior and inferior aspects of the neck of the humerus and permitted dislocation of the head of the humerus.

CASE 5. A farmer, aged forty-eight, fell between two trucks, his arm being forced into hyperabduction. This patient was admitted to the Hospital, and was operated upon before his shoulder was reduced. At operation, the capsule was found to have been torn away from the anterior and inferior aspects of the neck of the humerus. In this case the subscapularis tendon was also torn away from its attachment to the humerus. The glenoid cavity was covered by the capsule and subscapularis tendon. Attempts to reduce the dislocation by traction and Kocher method failed. Therefore, the head of the humerus could not have been replaced by a closed reduction. After reduction the capsule was reattached to the neck of the humerus.

Dislocations on Fresh Cadavera

This study was made on fifty acute dislocations of the shoulder produced on twenty-five fresh cadavera. The capsule was torn either from the neck of the humerus or the neck of the scapula, depending upon the direction of the applied force.

A force applied in continued abduction tears the capsule from the neck of the humerus. A force started in abduction of 90 to 105 degrees, and then supplemented by impaction, tears the capsule from the neck of the scapula.

Recurrent Dislocations

In the first eight cases in this series of twenty-five consecutive cases of recurrent dislocations, the shoulder was first redislocated under anaesthesia before the exposure was made. In the remaining seventeen cases, the capsule was examined without dislocation, by first cutting a strip of the capsule just above the tendon of the long head of the biceps, three-eighths of an inch wide, beginning at the distal edge of the transverse humeral ligament, and exposing it up into the coracohumeral ligament and supraspinatus tendon. The long head of the biceps was divided three-quarters of an inch distal to the lesser tuberosity. A long curved clamp was placed in the joint and the capsular attachments were explored.

In nineteen cases the capsule was found to have been torn from the neck of the scapula; in six the capsule was found to have been torn from

the neck of the humerus. In these cases the edge of the torn capsule was incorporated in a very thin fibrous membrane, which made it difficult to see the edge of the torn capsule.

In 100 per cent. of the cases in this series of recurrent dislocation of the shoulder, the recurrence followed a traumatic dislocation produced by sports. The shoulders were immobilized, after the initial dislocation and reduction, for periods varying from two to five weeks. It was possible, when a history could be obtained of the trauma, to predict the location of the tear of the capsule,—if the trauma was hyperabduction, then the capsule was torn from the neck of the humerus; if hyperabduction with impaction, then the capsule was torn from the neck of the scapula.

TREATMENT

In acute dislocations in young, vigorous individuals who expect to return to active sports, the author believes that the shoulder should be operated upon at the time of the first dislocation. The operation should consist of reattaching the capsule to the neck of the humerus or the neck of the scapula, depending upon the location of the tear. In addition, the long head of the biceps should be passed through the head of the humerus at least one-half inch from the edge of the articular cartilage.

In recurrent cases, the capsule should be explored to determine the location of the tear. After repairing this, the shoulder should be reinforced with the long head of the biceps, together with a strip of the capsule which lies above it.

CONCLUSIONS

The location of the tear of the articular capsule varies in different cases, and depends upon the force,—hyperabduction tears the capsule from neck of the humerus, and hyperabduction plus impaction tears it from the neck of the scapula.

Open operation on initial acute dislocations in young individuals who expect to return to active sports will give a higher percentage of cures.

MACRODACTYLY AND ASSOCIATED PERIPHERAL NERVE CHANGES

BY BEVERIDGE H. MOORE, M.D., CHICAGO, ILLINOIS

Macrodactyly or megalodactylia is one of the rarer forms of congenital deformity seen in orthopaedic clinics. It is in reality a form of localized hypertrophy, but it seems especially interesting on account of the peculiarly bizarre deformities it often produces. The literature dealing with the condition is not abundant, and consists mainly of reports of single cases. More of the cases have been reported from the Latin countries—particularly from South America—than in the English literature. Whether this is of any significance as indicating relative frequency in geographical location is doubtful, since most of the reports are of single cases. None of the patients in this series were of Latin extraction, and, judging from the names, all but one were of northern European stock. Of this series of five cases, one was seen at Northwestern University Medical School, and four at the Shriners' Hospital for Crippled Children.

For the sake of brevity a detailed description of the deformities in each case is not given. The illustrations afford a much more definite idea of the appearance of the affected member.

CASE 1.* E. M., a Filipino male, aged twenty years, was seen at Northwestern University Medical School, and was admitted to Wesley Hospital on July 26, 1920.

He complained of difficulty in opening and closing the two middle fingers of his right hand. It was noted that these two fingers were considerably larger than the normal proportion and that there was a distinct bulging of the palm extending into the wrist. The patient said the fingers had been enlarged as long as he could remember. The skin of the palmar surface of the hand was coarse in texture, thickened, and somewhat wrinkled. The difficulty in opening and closing the fingers was ascribed to obstruction of the flexor tendons at the annular ligament of the wrist. At operation the tendons were found to be normal, but the median nerve presented a marked fusiform enlargement which felt corded and fibrotic to touch. On opening the sheath, the fasciculi were found to be enlarged, corded, and fibrous. A small portion of one fascieulus was removed for microscopic examination. The annular ligament was closed *under* the nerve tumor, and the skin and fascia *over* it. This completely relieved the difficulty in opening and closing the fingers.

Examination of the biopsy specimen showed an enormous proliferation of fibrous tissue apparently from the endoneurium. This fibrous tissue completely overshadowed the nerve tissue. The diagnosis by Dr. Zeit was "neurofibroma of the *Ranken-neuroma* type".

CASE 2. R. K., a white male, aged twenty months, was seen on September 30, 1938, at the Shriners' Hospital.

The deformity was a marked overgrowth of the three outer toes of the left foot and the two outer toes of the right foot (Figs. 2-A and 2-B). The patient was one of twins, the other (a girl) had died shortly after birth. There was no history of any other deformities on either side of the family. The deformity had been present at birth, but the disproportion in the size of the toes had increased rapidly with growth. In addition

* Case 1 has been previously reported by the author.

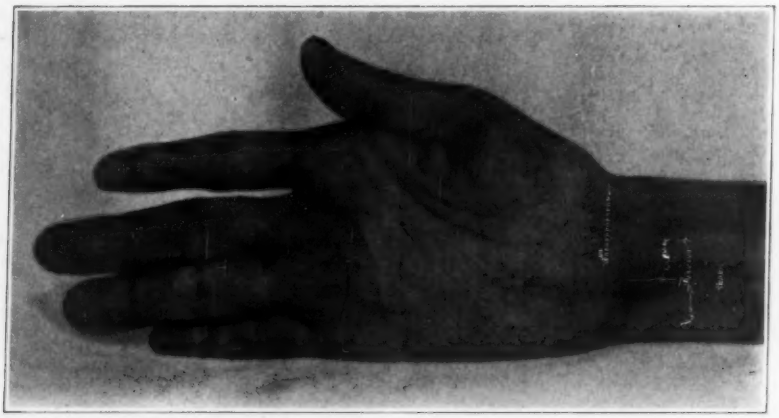

FIG. 1-A

Case 1. E. M. Postoperative photograph of the hand, showing the hypertrophy of the second and third fingers and swelling from the tumor at the base of the palm just above the line of incision. The change in the skin texture is seen down the middle of the palm.

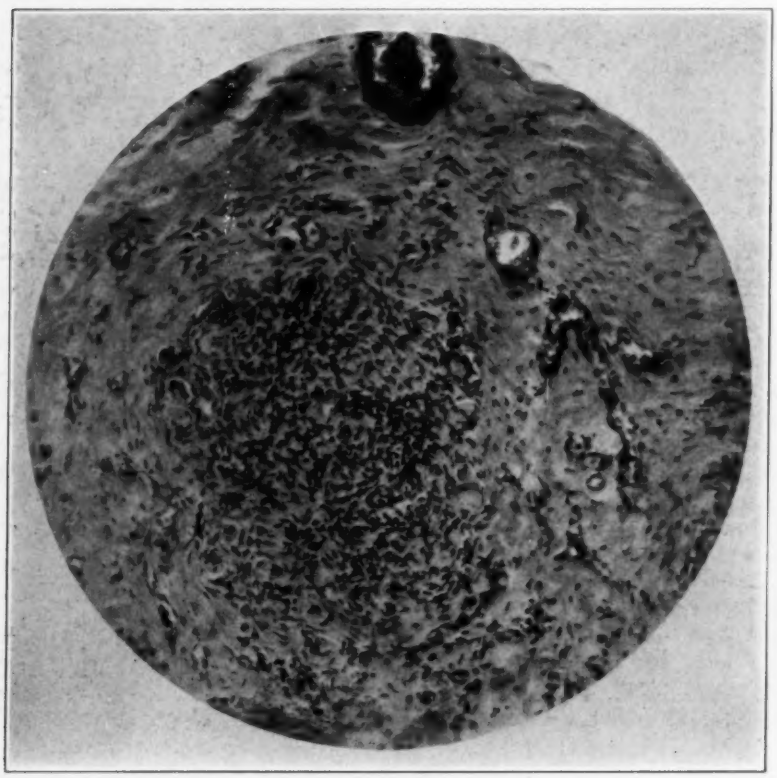

FIG. 1-B

Low-power photomicrograph showing the fibrous tissue largely at the periphery of the field, with very little of the so-called "palisade" but some parallel arrangement of the elongated and narrowed nuclei, most noticeable in the upper left quadrant. The few vacuolations seen are presumably from degeneration of nerve fibers. This is an old, mature type of tumor.

to the deformities of the feet, there were several large non-pedunculated fatty tumors present on the trunk. There was one definite, but lightly pigmented, *café au lait* spot on the right buttock.

Roentgenograms showed that the hypertrophy involved the bones of the affected toes, including the metatarsals as well as the soft tissues. The femur and the tibia and fibula of the left leg were slightly larger than those of the right.

Operation: A partial amputation including the fifth metatarsal and the fourth and fifth toes was done on the right foot on October 18, 1938. A similar operation, but including the third toe, was done on the left foot on January 10, 1939.

Peripheral Nerve Pathology: In this case it was very difficult to find a nerve in the amputated portion. After several attempts a complete cross section of one of the toes was made. In this a nerve composed of several fasciculi was found. In all of these there was a marked infiltration of fibrous tissue with an almost complete absence of axis cylinders (Figs. 2-D and 2-E).

Case 3. E. B., white male, aged one year, was seen at the Shriners' Hospital on June 3, 1938. The deformity was a marked enlargement of the first and second toes of the right foot (Fig. 3-A). In this case the entire right leg from the hip down was enlarged, but the two toes were much out of proportion even to the enlarged leg. In addition, there was a large purplish naevus over the surface of the leg extending over the buttock and lower back (Fig. 3-B). The left leg also showed patches of the same condition on the outer and posterior region. There were one or two *café au lait* spots on the back,

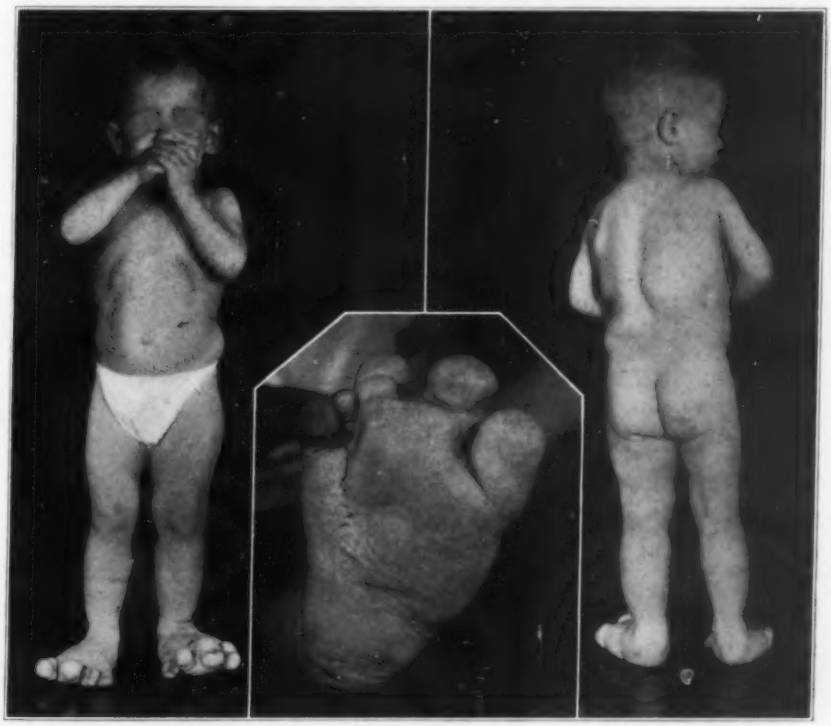

Fig. 2-A Fig. 2-B Fig. 2-C

Fig. 2-A: Case 2. R. K. Showing the deformities of the feet and toes. The entire left leg is slightly larger than the right.

Fig. 2-B: The sole of the left foot. The fifth toe is larger than the normal first.

Fig. 2-C: Back view. Note the lipomatous masses on the back. On the right buttock are two faintly colored, but definite *café au lait* spots.

FIG. 2-E

Oil immersion photomicrograph, showing marked increase of fibrous tissue.

FIG. 2-D

Case 2. R. K. Low-power photomicrograph of a nerve fasciculus, showing the general fibrosis.

though they were faintly pigmented. In addition, the mother showed several brownish pigmented areas on her face, and a number of small pedunculated skin tumors suggestive of von Recklinghausen's neurofibromatosis. Two older children were normal. The deformity was present at birth, but it had been increasing rapidly. On account of the extensive naevus formation no operative measures were attempted, except a biopsy on a small cutaneous nerve. This was reported to show an increase in the perineurial and endoneurial fibrous tissue. Unfortunately the tissue block was lost before more than the routine work could be done.

The patient received roentgenotherapy in an attempt to reduce the naevus; little or no result was obtained however. On October 24, 1941, he was again admitted. In the interval of three and a half years he had grown rapidly, and the disproportion between the two legs was not so marked. However, the two toes had grown at a much more rapid rate than the normal ones. The naevus had faded considerably. The *café au lait* spots were still present, and the pigmentation had not increased in them.

FIG. 3-A FIG. 3-B

Fig. 3-A: Case 3. E. B. Front view showing the overgrowth of the right leg and the enlargement of the first and second toes. The dark coloration on both legs is naevus formation. Near the costal margin on both the right and left side is a faint *café au lait* spot.

Operation: On November 8, 1941, amputation of the second toe and the distal phalanx of the first toe was performed.

Nerve Pathology: In this case also it was very difficult to find a nerve in the hypertrophied subcutaneous tissue, so a complete cross section of the amputated toe was made and sectioned. In this, two nerves with several fasciculi were found. The findings were an increase in the endoneurial nerve tissue. In this case, however, the fasciculi differed quite widely from each other (Figs. 3-C, 3-D, 3-E, and 3-F). In one the fibrous tissue was arranged in interlacing fibrils with almost no definite nerve tissue. This approached the classical picture of a neurofibroma. In another fasciculus the fibrous tissue was much more solid and in areas tended to whorl formation. The nerve fibers in this varied widely from very narrow compressed fibers to a few appearing almost normal. However, the fibrous tissue dominated the picture. In two or three other fasciculi the increase in fibrous tissue was slight, so the picture was that of a relatively normal nerve.

CASE 4. H. H., a white male, aged three years, was seen at the Shriners' Hospital on August 2, 1940.

The deformity was a very marked overgrowth of the first and second toes of the left foot (Figs. 4-A and 4-B). The deformity had been present at birth, but had been increasing ever since. He was the first and only child, and there was no history of any

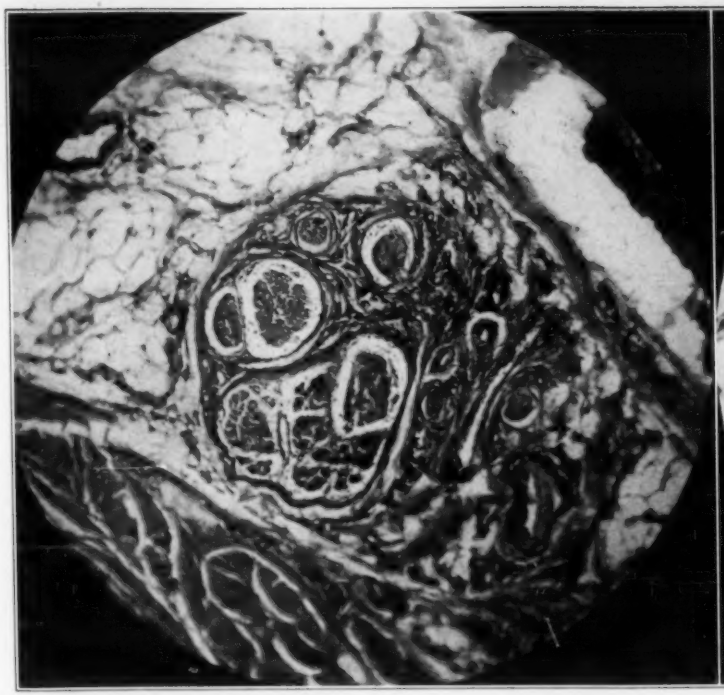

FIG. 3-C

Case 3. E. B. Low-power photomicrograph of one nerve, showing varying degrees of fibrosis in different fasciculi.

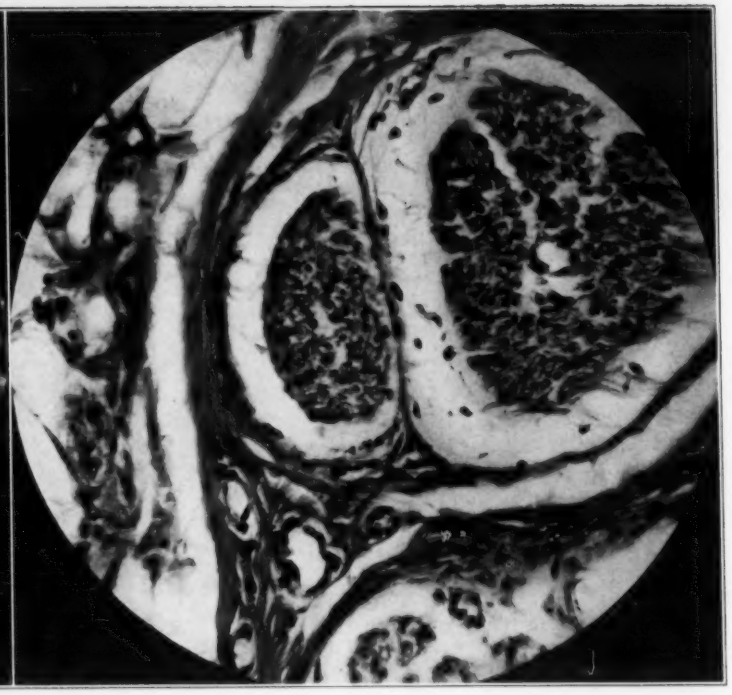

FIG. 3-D

High-power photomicrograph, showing some increase in fibrous tissue, but many relatively normal nerve fibers.

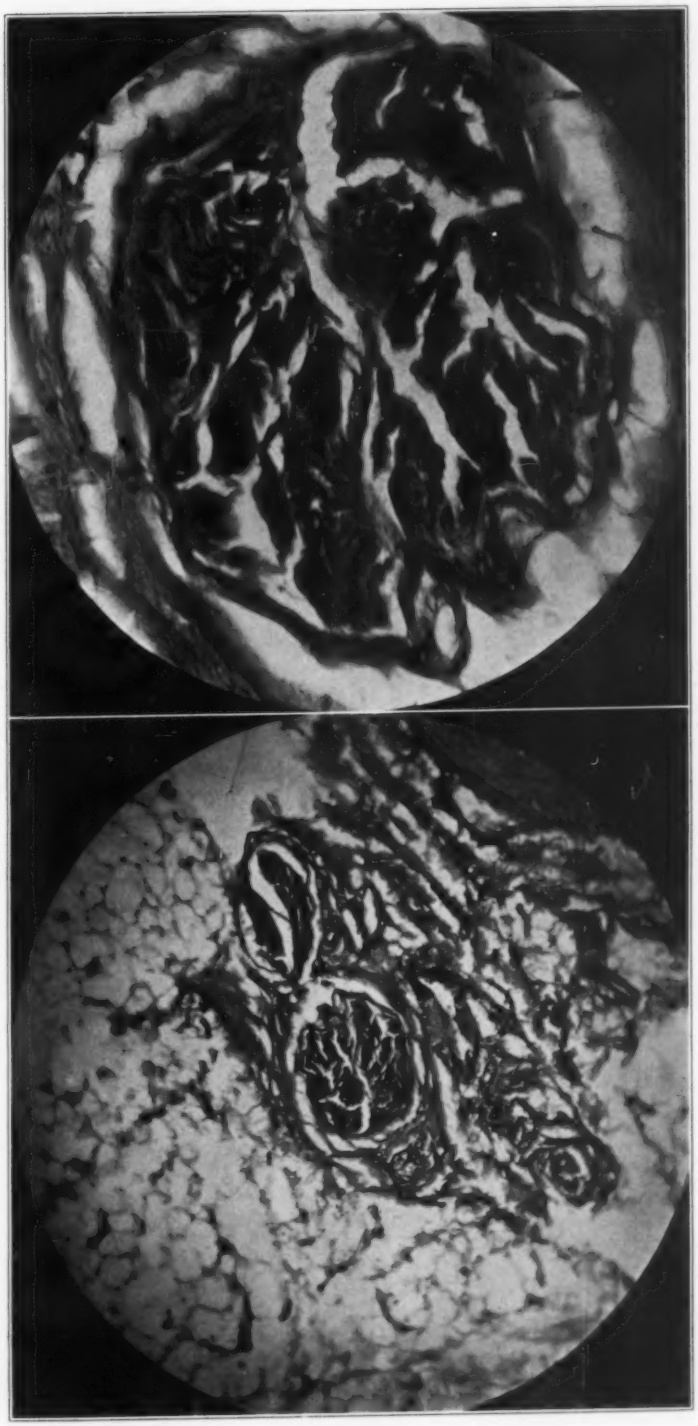

FIG. 3-F

Oil immersion photomicrograph of the same nerve, showing almost complete fibrosis. In the upper right quadrant is an area very closely resembling a definite neurofibroma.

FIG. 3-E

Case 3. E. B. Low-power photomicrograph of another nerve, showing definite fibrosis.

FIG. 4-A (Above) FIG. 4-B (Below)

Fig. 4-A (Above): Case 4. H. H. Lateral view of the left foot showing the enlargement of the toes.

Fig. 4-B (Below): The soles of both feet, showing the disproportion in the size of the toes.

deformities on either side of the family. One operation (apparently an attempt at epiphyseal arrest in the toe) had been done elsewhere at the age of nine months, but the deformity had continued to increase.

Operation: On September 9, 1940, an attempt was made to reduce the size of the toe by excision of a considerable portion of the skin and subcutaneous tissue. The result of this was unsatisfactory, and an amputation of the first and second toes was done on October 17, 1940.

Peripheral Nerve Findings: Sections showed a very marked increase in the fibrous tissue of the endoneurium (Figs. 4-C and 4-D). The perineurium, also, was markedly thickened. Very few axis cylinders were found in any of the fasciculi. Silver impregnation stains showed that there were nerve elements present, but diminished in number and completely overshadowed by the fibrosis.

CASE 5. M. J. B., a white female, aged two years, was seen at the Shriners' Hospital on November 8, 1940.

The deformity consisted of a moderate enlargement of the third and fourth toes of the right foot. The third toe was much larger than the fourth. The deformity had been present at birth, and the disproportion of the toes had increased at a moderate rate. One other child was normal, and there was no history of deformity on either side of the family.

Operation: On February 27, 1941, the third toe, including the head of the metatarsal, was amputated.

Nerve Pathology: Examination of a nerve removed from the amputated toe, showed a marked increase in the fibrous tissue apparently from the endoneurium. The perineurium in this case was not thickened. Axis cylinders were rare, and, where found, the myelin was frequently narrowed, suggesting compression by the fibrous tissues.

Clinical Résumé. In all these cases there was a marked localized overgrowth of one or more digits. This overgrowth involved all the tissues of the affected member,—the skin and nails, the subcutaneous tissue, and the bone. The skin in all of them showed marked thickening

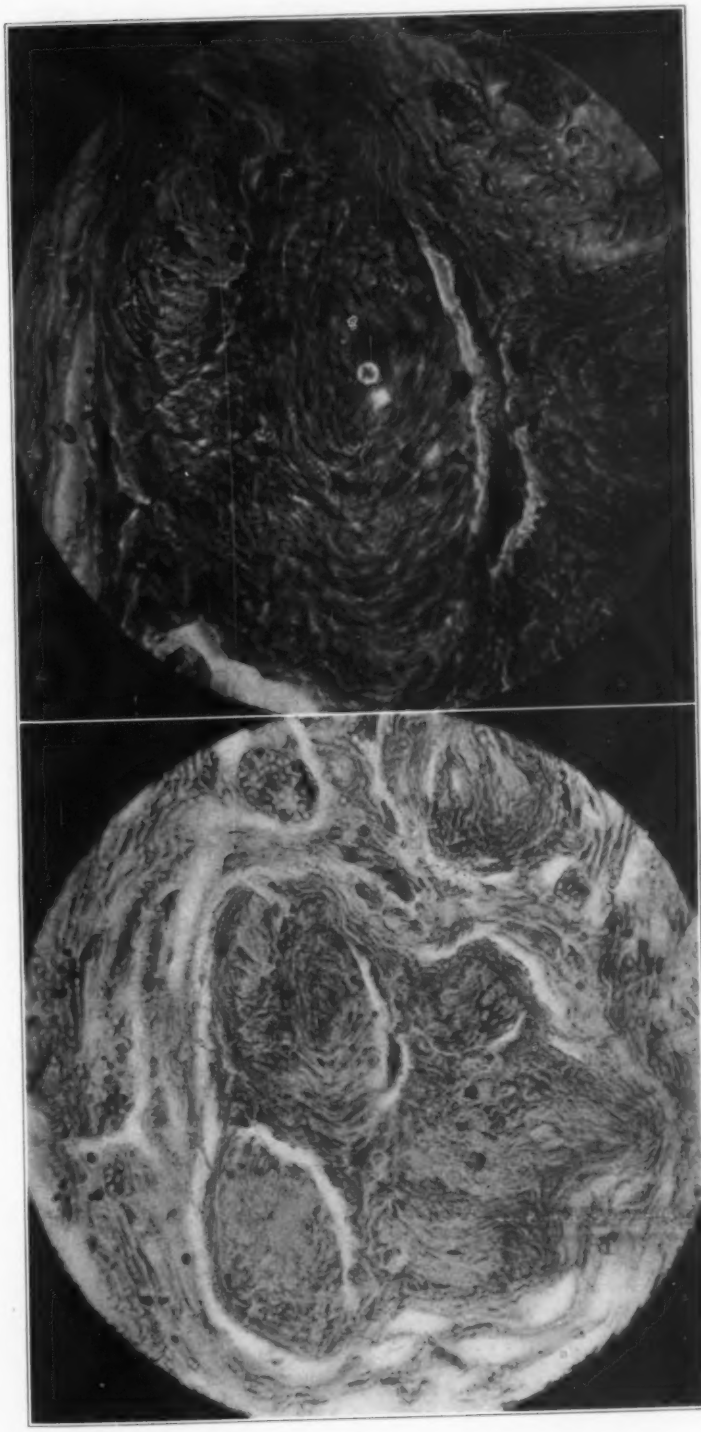

FIG. 4-D

High-power photomicrograph of a portion, showing almost complete fibrosis. There is a distinct whorl formation of the fibrous tissue.

FIG. 4-C

Case 4. H. H. Low-power photomicrograph of a nerve fasciculus, showing a marked increase of endoneurial fibrous tissue.

and changes in texture, the markings being coarse, and the skin itself somewhat wrinkled and dimpled. In the four children, who of course were still growing, the affected digits were growing at a more rapid rate than the normal ones, so that the disproportion was increasing. In two of the cases, the entire leg on the side of the deformity was larger than the normal one. The only other gross deformities associated with the condition were the large lipomata in Case 2 and the naevi in Case 3. In two of the cases there were *café au lait* spots such as are seen in cases of von Recklinghausen's disease in children. In both cases the spots were definite in outline, although the pigmentation was rather faint and might be overlooked on casual examination. In one of these two cases (Case 3) there was also evidence of von Recklinghausen's disease in the mother, which may be regarded as collateral evidence since the condition is frequently hereditary. Attention is called to this finding particularly as its implications will be discussed more fully later.

Pathological Résumé: In Case 1 (the only adult in the series), the nerve condition was definitely diagnosed, on microscopic examination, as a neurofibroma. In the other four cases (all children) there was a marked similarity in the nerve pathology in all, but none of them were definitely diagnosed as neurofibroma. The most striking and obvious change was the marked increase in the fibrous tissue in the fasciculi. This was entirely out of proportion to the amount of supporting tissue seen in normal nerve sections. This increase in fibrous tissue was mainly endoneurial, but with varying degrees of involvement of the perineurium. The nuclei of the fibrous tissue

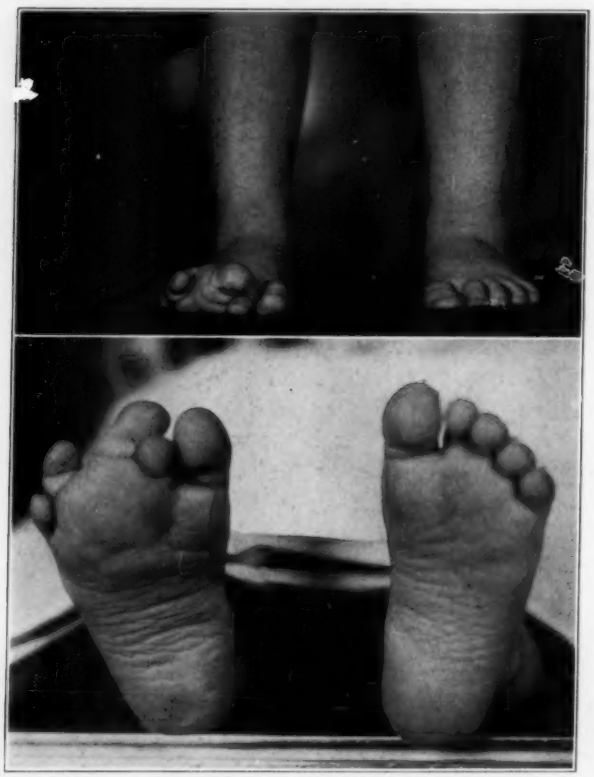

FIG. 5-A (Above) FIG. 5-B (Below)

Fig. 5-A (Above): Case 5. M. J. B. Anterior view showing the deformities of the toes. The small dark area near the middle of the leg is not a typical *café au lait* spot, but it has persisted and may be of that nature.

Fig. 5-B (Below): View of the soles of both feet.

FIG. 5-D

Oil immersion photomicrograph of a portion of one fasciculus, showing marked infiltration of fibrous tissue with only slight remains of nerve tissue.

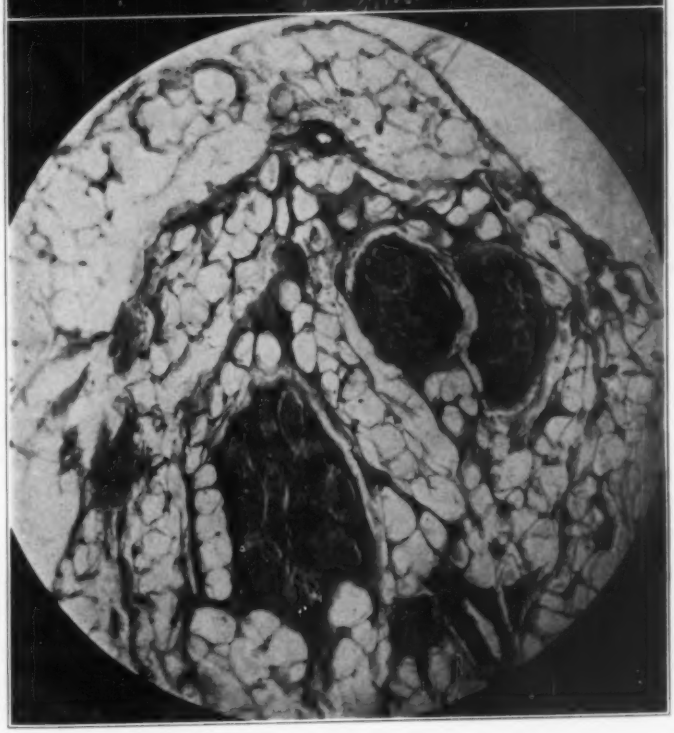

FIG. 5-C

Case 5. M. J. B. Low-power photomicrograph of three nerve fasciculi, showing an increase in fibrous tissue.

were large and more numerous than in normal nerve tissues,—a probable indication that the fibrosis was progressing. In the sections, the fibrous hyperplasia completely overshadowed the nerve elements present. That nerve elements were present was shown by silver stains. There were also changes in the nerve elements as shown by the van Gieson stain. The axis cylinders were much diminished in number, and in many of the sections the myelin sheath was swollen and vacuolated. Another deviation from normal was the almost complete absence of Schmidt-Lautermann structures in the nerve fibers. A few of these could be found only by careful searching. These findings would seem to be indicative of definite degenerative changes in the nerve fibers themselves. The pathological changes noted may be summed up as an increase in the fibrous elements of the nerve fasciculus, with evidence of degenerative changes in the nerve fibers. The author has been calling these changes fibrotic degeneration. Whether the fibrosis or the degenerative changes are primary is still an open question.

Nageotte states that a nerve fiber losing its axis cylinder becomes sclerogenic, which would place the fibrosis secondary to the degenerative changes. On the other hand, there are areas in several of the sections in which there is a strong suggestion that the fibrous tissue may be encroaching upon the nerve fibers and choking them out. Which is the primary process seems very difficult to determine definitely. At any rate, in this series of cases, the association of macrodactyly with pathological changes in the peripheral nerves has been constant. The pathologists with whom the slides have been discussed have all agreed that the changes are definitely pathological, but they have not all agreed as to their classification.

Localized hypertrophy of various portions of the body have rather frequently been found in cases showing clinical stigmata of von Recklinghausen's neurofibromatosis. Brooks and Lehman reported such a series of leg hypertrophies. Campbell reported a case of congenital hypertrophy of one leg, in which biopsy confirmed the clinical evidence of neurofibromatosis, The author has reported three similar cases of overgrowth of one leg, which showed not only clinical evidence of neurofibromatosis, but definite confirmation by biopsy. Winestine reported an autopsy in which localized overgrowth of a segment of the intestine was found associated with neurofibroma of the nerve supplying that segment. With this evidence of association of localized overgrowth and nerve pathology, it seemed logical to examine the nerves in cases of macrodactyly. However, in only one other reported case has any mention of investigation of the peripheral nerves been found. Baraldi and Ruiz reported a case of marked overgrowth of a thumb and forefinger, in which there was found a tumor of the median nerve diagnosed as a neurinoma. It may be noted that many pathologists do not make a sharp distinction between neurinoma and neurofibroma, so the difference in diagnosis may be largely a matter of terminology. Certainly the

photomicrograph of the case of Baraldi and Ruiz very closely resembled the findings in the author's Case 1.

Brooks and Lehman in discussing their cases of localized overgrowth expressed the belief, "there is no other cause for rapid overgrowth of an extremity than neurofibromatosis", or, to put it in other words, they consider localized giantism as one of the signs of neurofibromatosis, though not an essential one,—that is, neurofibromatosis may be present without localized overgrowth, but localized overgrowth presupposes the presence of neurofibromatosis. The classical signs of the condition as given in the textbooks are:

1. Pigmented areas in the skin (*café au lait* spots).
2. Cutaneous tumors, pedunculated or sessile.
3. Plexiform tumors of the nerve trunks.

It should be noted that the cutaneous tumors occur rarely in children, even when typical pigmentary changes are present, but they frequently develop in these cases during late adolescence.

In this series of macrodactyly, of the four children, two showed definite pigmentary changes, and a third was indefinite but suggestive in this respect. None of them had cutaneous tumors, and in none of them were there palpable tumors of the nerve trunks.

The author has already mentioned that, while the histology of the nerves in the children was definitely abnormal, it was difficult to classify the condition as neurofibromatosis. If one accepts Dorland's brief definition of neurofibroma as "a connective-tissue tumor of the nerve fiber fascicule, formed by proliferation of the perineurium and endoneurium", then the condition here described might be so classified. It must be considered that the nerve tissue available for examination in these cases was only from the smaller terminal cutaneous branches. (Incidentally, they were very difficult to find in the mass of fatty subcutaneous tissue.) No information is available as to the condition of the larger nerve trunks. To offset this, the opportunity has been taken in other cases of proved neurofibromatosis, to examine the finer terminal branches of the nerves, and a pathological picture has been found strikingly like that in the sections from the cases of macrodactyly. There is a possibility that the larger portions of the nerve trunks might show more classical types of neurofibroma. There is still another possibility to be considered.

The one case in which a typical neurofibroma was found was a young adult. The others, in which only an increase in endoneurial fibrous tissue (referred to as fibrotic degeneration) was found, have been in young children. This raises the question as to whether a neurofibroma in a child is the same as in an adult. The process may be progressive, and the findings in the author's sections might be different later in life. This is, of course, theoretical, and will need further observation before the question can be answered. Some slight evidence on the point is the clinical fact, already mentioned, that skin tumors are rare in children, but that they frequently develop in cases which show only *café au lait* pigmenta-

tion in early childhood. This certainly indicates some progression and change in the condition. The progression in the clinical features of neurofibromatosis has been observed and commented on many times. It has led to the generally accepted theory that neurofibromatosis is a congenital condition, and that it passes through various phases of development. This theory has been the outgrowth of clinical rather than histological observation, but if the author's findings in the nerves represent an early stage of neurofibromatosis (as he feels they do) they tend to confirm the developmental theory.

Another point to be considered is whether the nerve pathology is to be regarded as the cause of the malformation of the member. One objection to so believing is that, since we are dealing with a malformation in which all the structures (skin, bones, and subcutaneous tissues) are abnormal, it would be expected that the nerves would also be abnormal. Brooks and Lehman, who have been quoted, did consider that the nerve condition was the cause of the overgrowth and that it acted by direct stimulation. However, another mechanism must be considered. The growth of members of the body is the result of two factors, — the growth impulse and some factor or group of forces limiting and directing the growth into the normal pattern. If this latter inhibitory factor fails to act, the result would be abnormal growth. The author feels that the nervous system may be the regulatory mechanism. However, this cannot be definitely proved. It does, however, suggest an interesting, but difficult research problem.

SUMMARY AND CONCLUSIONS

Five cases of macrodactyly are presented, in all of which pathological changes were found in the peripheral nerves. In one (a young adult), the changes were definitely classed as due to a neurofibroma. In the four others (all young children), the changes were an increase in endoneurial fibrous tissue, with evidence of degenerative changes in nerve fibers. Three of the four children showed at least some of the clinical stigmata of neurofibromatosis. It would seem then that the changes shown in these nerves may represent an early stage in the development of a neurofibroma. Case 3 is particularly suggestive in this regard.

The fact that local hypertrophy is so constantly associated with peripheral nerve pathology, would seem to indicate that there is a relationship between them. It is believed that the nervous system exerts some controlling action on the process of growth, and that the impaired nerves fail in this function, resulting in uncontrolled or uninhibited growth. Whether there are changes in the central nervous system which result in the change in the peripheral nerves is not known.

These observations seem to favor the neurogenic theory as the origin of at least certain types of congenital deformities. The author feels that the investigation of pathology in the peripheral nerves has been somewhat overlooked, and that more careful work along this line might be of great interest.

The author feels indebted to Loyal Davis, M.D., for interest in this investigation. On the pathological changes he has received help and valuable suggestions from Arthur Weil, M.D., Francis D. Gunn, M.D., and Hamilton R. Fishback, M.D., of Northwestern University Medical School. George J. Rukstinat, M.D., of Rush Medical College, has also been very helpful in carefully studying the pathological slides.

REFERENCES

Baraldi, A., y Ruiz, F. R.: Megaloquiria distrófica parcial secundaria a neurinoma del mediano. Rev. Méd. del Rosario, XXIV, 1243, 1934.

Brooks, Barney, and Lehman, E. P.: The Bone Changes in Recklinghausen's Neurofibromatosis. Surg. Gynec. Obstet., XXXVIII, 587, 1924.

Campbell, W. C.: Congenital Hypertrophy. Report of a Case with Diffuse Neurofibromatosis. Surg. Gynec. Obstet., XXXVI, 699, 1923.

Moore, B. H.: Some Orthopaedic Relationships of Neurofibromatosis. J. Bone and Joint Surg., XXIII, 109, Jan. 1941.

Nageotte: *In* Wilder Penfield's Cytology and Cellular Pathology of the Nervous System. Vol. I, p. 216. New York, Paul B. Hoeber, Inc., 1932.

Winestine, Frederica: The Relation of von Recklinghausen's Disease (Multiple Neurofibromatosis) to Giant Growth and Blastomatosis. J. Cancer Research, VIII, 409, 1924.

A MODIFIED OPERATION FOR OPPONENS PARALYSIS *

BY T. CAMPBELL THOMPSON, M.D., NEW YORK, N. Y.

From the Hospital for Special Surgery, New York

The power of opposing the thumb to the fingers is one important way in which man differs from the rest of the animal kingdom, and is the fundamental reason for his manual dexterity. Loss of the power of opposition is a much greater disability than those of us who possess it can realize. Restoration of this power has not interested orthopaedic surgeons as much as it really should, although some of them have realized the importance of this function and several ingenious operations have been devised to restore it. No attempt will be made to enumerate or describe all of the operations that have been designed, but the author would like to explain the Royle operation together with a modification which has been developed in the past few years at the Hospital for Special Surgery, formerly known as the Hospital for Ruptured and Crippled.

The operation designed by Royle is described as follows:

"Step 1.—The skin is opened through the transverse fold at the base of the ring finger. By retracting the skin distally, one can reach the insertion of the bifurcated tendon of the flexor sublimis with a tenotome, with which it is then cut through on each side.

"Step 2.—The sheath of the flexor pollicis longus is opened through an incision at the deep fold proximal to the metacarpophalangeal joint of the thumb.

"Step 3.—An incision is made in one of the transverse folds of the palmar aspect of the wrist. The cut tendon of the ring finger is then drawn out through this incision. It is *passed up the sheath of the long flexor of the thumb* † and brought out at the incision at the metacarpophalangeal joint of the thumb.

"Step 4.—The attachment of the short flexor [of the thumb] and of the opponens pollicis is next exposed by dissecting up the skin distally. One part of the bifurcated tendon of the superficial flexor of the ring finger is stitched to the attachment of the short flexor with the first phalanx in flexion. The other part is stitched to the outer edge of the opponens pollicis with the thumb in opposition."

The apparent simplicity of this procedure has probably appealed to many orthopaedic surgeons. Several such operations were done at this Hospital shortly after this article appeared. Experience with the technique of the procedure showed it to be not nearly so simple as one would expect, and the results were not so satisfactory as one would wish. In Royle's description of the procedure, he pulls the flexor sublimis tendon of

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 4, 1942. Received for publication March 9, 1942.

† The italics are the author's.

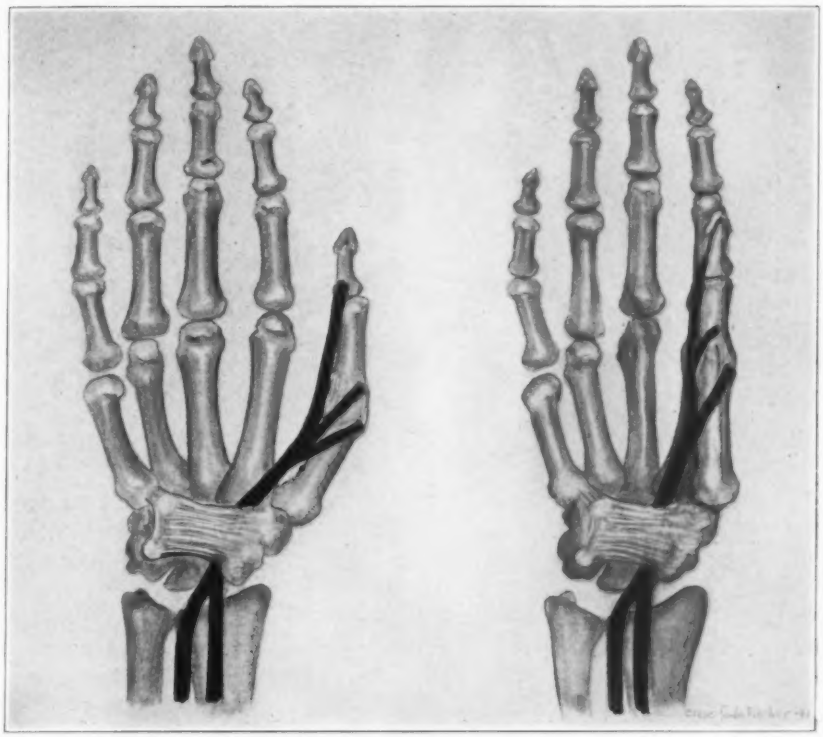

FIG. 1
Diagram showing the mechanics of the Royle or Steindler operation.

the fourth finger *distally* through the sheath of the flexor pollicis longus tendon. It fits into its sheath quite tightly and there really is no room for an additional tendon. Considerable difficulty is encountered in sliding this extra tendon down through the sheath, and this may be one reason why the action of the transplanted tendon is not too satisfactory later. The tendon emerges from the sheath of the flexor pollicis longus somewhere along the shaft of the first metacarpal bone. The same is true in Steindler's operation where the flexor pollicis longus tendon itself is split, and the radial half is brought out of the sheath and around the first metacarpal. The mechanics of these two procedures are essentially the same, in that the pulley from which the rotation takes place is *really the exit* of the tendon from the sheath of the flexor pollicis longus. The action of the tendon, down to the point where it emerges from the sheath, is really exactly the same as that of the flexor pollicis longus. The point of exit of the tendon from the sheath is not far enough away from the axis of the shaft of the first metacarpal bone, nor from the point of insertion of the tendon into the bone, to insure a good range of adduction and rotation. In order to produce efficient rotation of a bone, the muscle or tendon should run as nearly as possible at a right angle to the shaft of bone, rather than in a long spiral around it. It is a well-recognized mechanical prin-

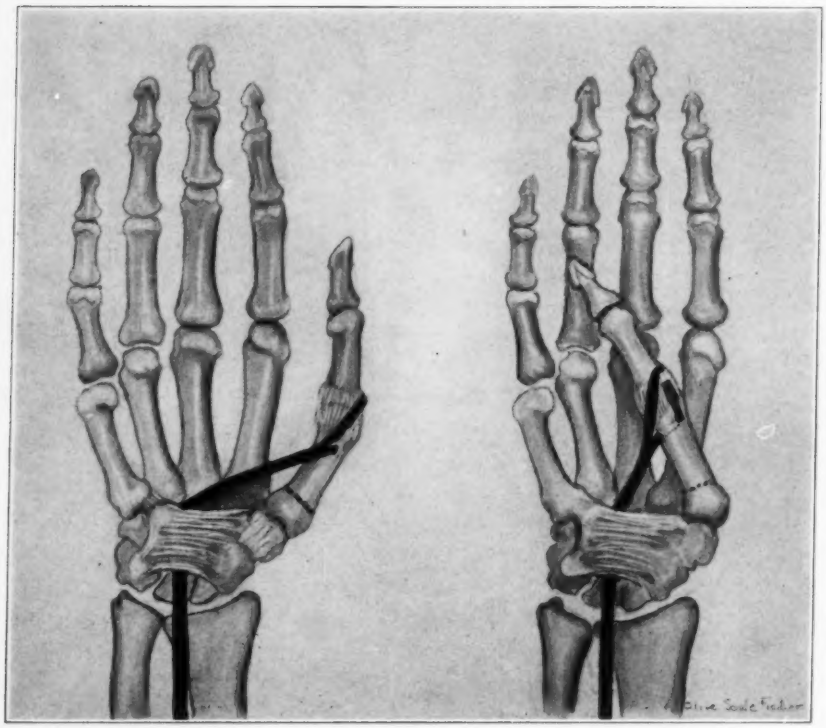

FIG. 2

Diagram showing the mechanics of the modified operation. Note that the pulley at the lower margin of the transverse carpal ligament is well away from the base of the first metacarpal bone.

ciple that, in any type of lever, the farther away from the fulcrum the power is applied, the stronger will be the action. In muscles this applies both to the origin and the insertion. (In an extrinsic muscle of the hand, the pulley next to the point of insertion corresponds to the origin of an intrinsic muscle.) Bunnell has emphasized the importance of placing the pulley well away from the base of the thumb in attempting to restore opposition, but his methods are so complicated that few surgeons will attempt them. He often uses the distal end of the flexor carpi ulnaris to form a pulley near the pisiform bone. Irwin has recently described a similar procedure.

Most operations for restoring opposition have advised inserting the transplant into the distal end of the first metacarpal bone. If the tendon is inserted beyond the metacarpophalangeal joint, it will act as a flexor of this joint and will not rotate the whole thumb, which is the action for which we are striving. Royle has inserted one-half of the tendon of the flexor sublimis of the fourth finger into the distal end of the first metacarpal and the other half into the base of the proximal phalanx. In his description he states that he sutures this distal half into the insertion of the *flexor pollicis brevis*. This would produce flexion at the metacarpo-

phalangeal joint, rather than rotation. However, in his illustration he shows both parts of the sublimis tendon sutured well over on the dorsal surface of the thumb, so that they would really act as a rotator and pull the thumb into opposition.

In the anatomy review courses that have been given by, and for, the house staff of the Hospital for Special Surgery in the last two years, the opportunity has been taken to test out some of the procedures for restoring opponens action of the thumb. It has been found that a modification of the Royle operation will produce much more efficient opposition than any other procedure. On the cadaver, it was found that the flexor sublimis tendon of the fourth finger could be identified quite readily through a short longitudinal incision at the base of the palm of the hand just to the radial side of the hypothenar eminence. This incision was just to the ulnar side of the median nerve. When the tendon had been severed at the base of the fourth finger, as described by Royle, it was drawn out through this incision in the palm *below*, instead of above, the transverse carpal ligament. From this point it was drawn subcutaneously across the center of the thenar eminence to the distal end of the first metacarpal bone, and the base of the proximal phalanx of the thumb. A pulley at some distance from the base of the thumb was thus formed by the lower border of the transverse carpal ligament. The action in adduction, and especially in rotation of the thumb, was much more efficient than when the tendon was brought out above the wrist and threaded distally through the sheath of the flexor pollicis longus. A slight, but important, change was also made in the method of inserting the transplanted flexor sublimis tendon. A dorsal incision was made along the line of the extensor pollicis longus tendon, instead of the one described by Royle. A hole was drilled through the distal end of the first metacarpal, so that the tendon would enter this bone just to the radial side of the extensor pollicis longus. The external rotating action of these two muscles, which are usually present, is difficult to overcome. One half of the transplanted muscle was threaded through this hole and the metacarpal bone pulled over into as much opposition as possible. The other half of the tendon was then brought around the dorsal surface of the thumb, superficial to the extensor pollicis brevis and extensor pollicis longus tendons, and drawn through a small tunnel in the fascia and periosteum at the base of the proximal phalanx. The two ends of the transplanted sublimis tendon were then sutured together. In this way full internal rotation of the metacarpal bone was secured, and a little additional rotation was obtained at the metacarpophalangeal joint without causing flexion at this joint. Since finding that this worked to so much better mechanical advantage on the cadaver than the procedure described by Royle, a number of patients have been operated upon with this technique. The results have been most encouraging.

Mayer, who has been interested in restoration of opposition of the thumb, has emphasized the point that in patients who have had paralysis

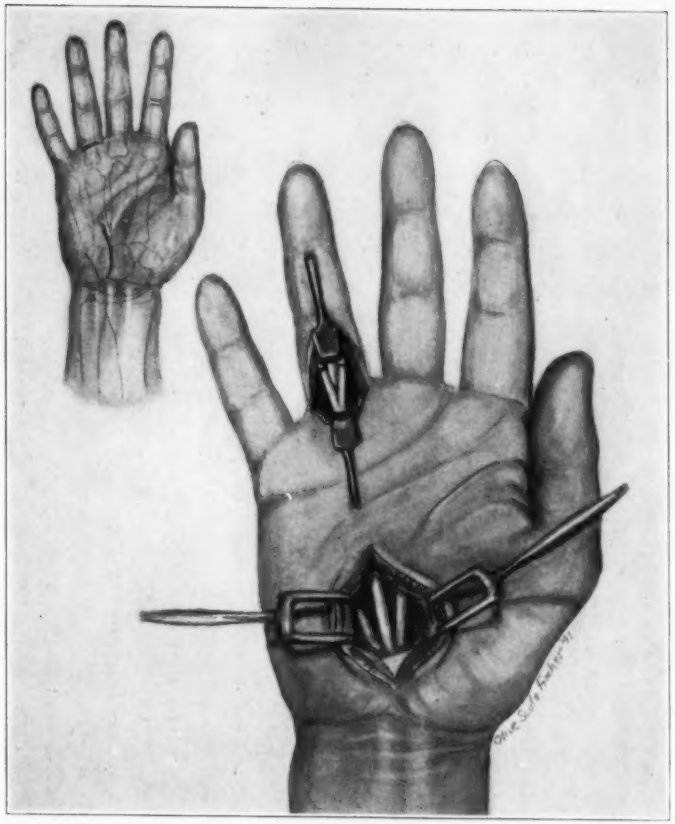

FIG. 3

(Steps 1 and 2) Incisions in the palm and exposure of the flexor sublimis to the fourth finger.

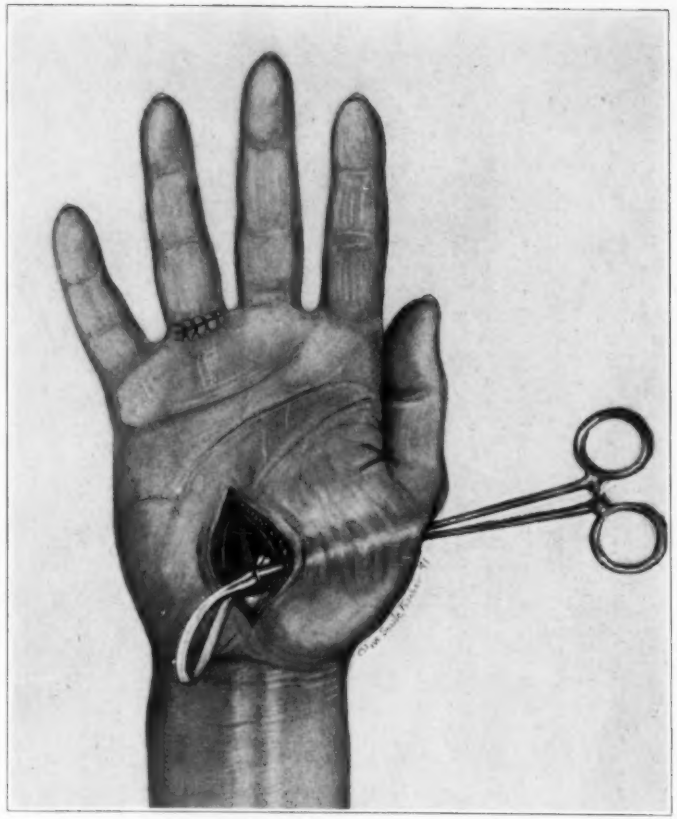

FIG. 4

(Steps 3 and 5) The flexor sublimis tendon is pulled across the thenar eminence through the subcutaneous tunnel.

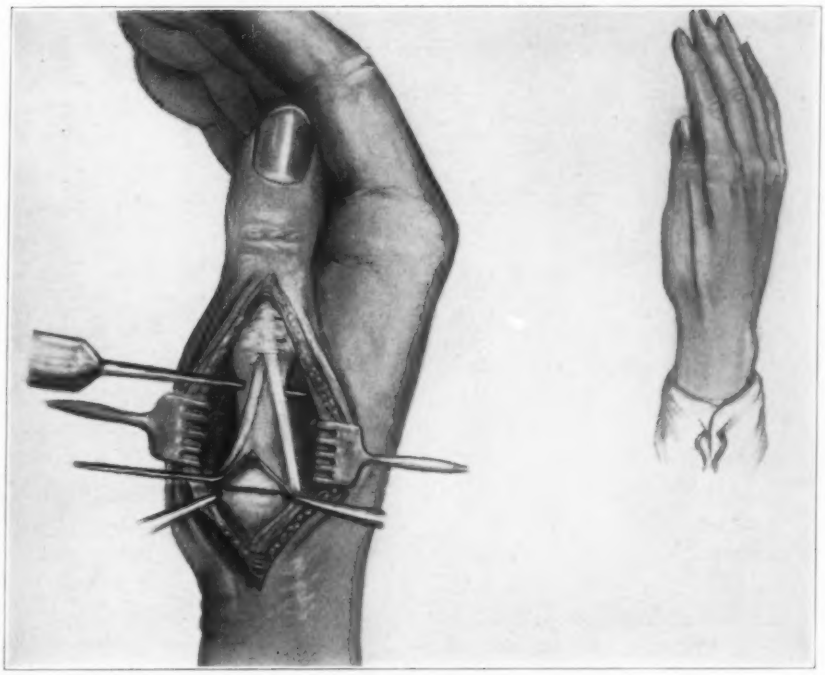

FIG. 5

(Steps 4, 6, and 7) An osteotomy at the base of the first metacarpal is done if the deformity is fixed.

for some time a fixed deformity develops, which cannot be easily overcome. He has advised capsulotomy of the joint at the proximal end of the first metacarpal to relieve this contracture. Even after a thorough capsulotomy, rotation of the thumb may still be quite difficult. In these cases where the deformity is so fixed that passive opposition cannot be obtained, the author thinks that the easiest, surest, and most satisfactory way of putting the thumb in a position of opposition is to do an osteotomy near the base of the first metacarpal and rotate the thumb into the desired position. One cannot expect a transplanted muscle to act strongly enough to correct a fixed deformity. The deformity must be corrected separately, and the tendon transplant merely serves to give active power in the new position. It might be preferable to do the osteotomy and the tendon transplant at different times. Certainly some of the author's results would have been better if the fixed deformity had been adequately corrected.

The steps in the modified operation are as follows:

Step 1. An incision is made in the palm three centimeters in length at the radial side of the hypothenar eminence, and the flexor tendons are exposed at the lower border of the transverse carpal ligament. The flexor sublimis tendon to the fourth finger is identified, and a blunt hook is placed around it (See Figure 3).

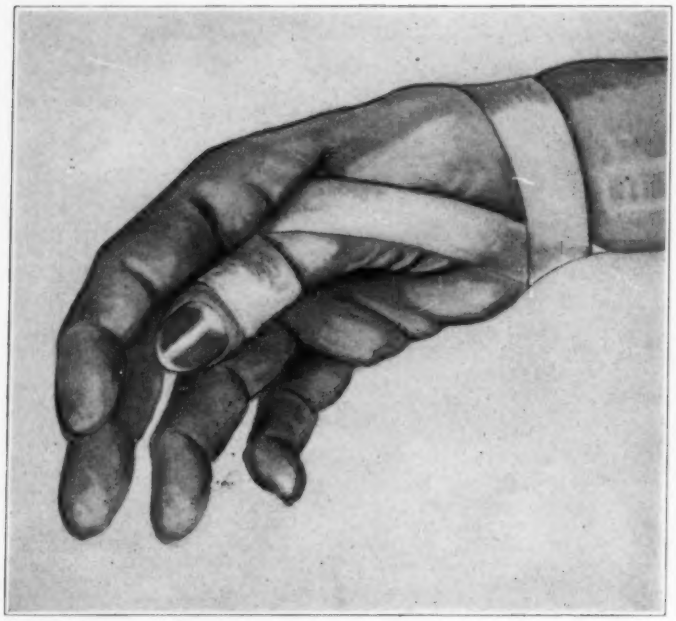

FIG. 7

Fig. 6: (Steps 7, 8, and 9) The split ends of the tendon are fastened firmly, holding the thumb in opposition.

Fig. 7: (Step 10) Spiral adhesive strapping holds the thumb in a position of opposition.

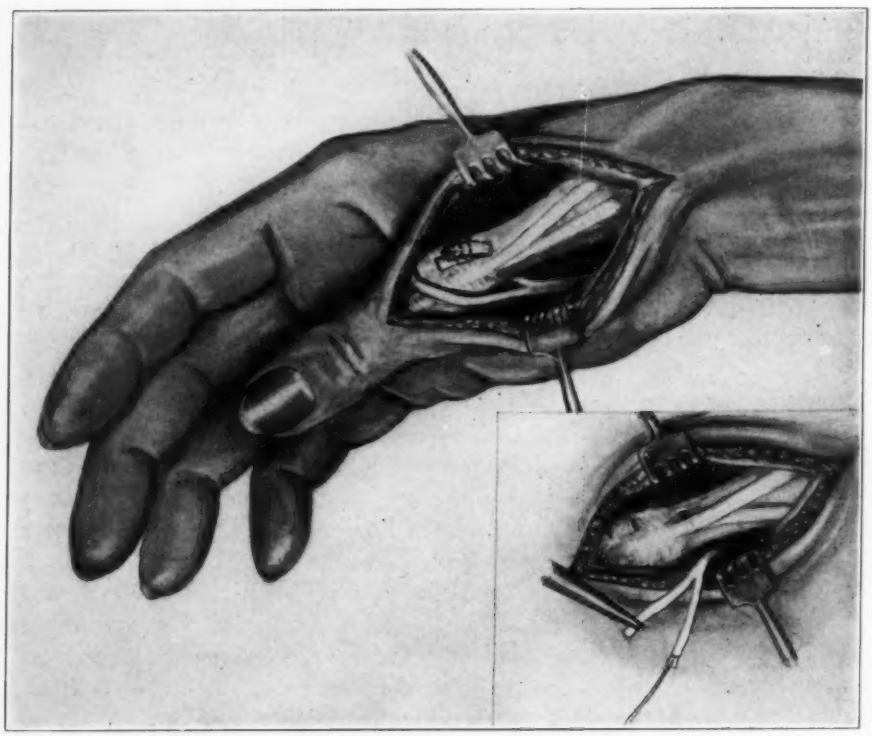

FIG. 6

Step 2. The flexor sublimis tendon is exposed through a transverse incision at the base of the fourth finger, and the two heads are sectioned as described by Royle (See Figure 3).

Step 3. The tendon is drawn out through the incision in the palm, and the incision at the base of the fourth finger is closed (See Figure 4).

Step 4. The hand is turned over and an incision is made on the dorsal surface of the thumb over the extensor pollicis longus tendon (See Figure 5).

Step 5. A subcutaneous tunnel is made across the thenar eminence, and the tendon of the flexor sublimis to the fourth finger is pulled through this tunnel (See Figure 4). The incision in the palm is closed.

Step 6. A hole is drilled through the first metacarpal near the distal end of the bone. This enters on the radial side of the extensor tendons and comes out on the ulnar side of them (See Figure 5).

Step 7. One-half of the transplanted tendon is drawn through this hole. If the first metacarpal is not pulled into sufficient opposition by this tendon, the incision is lengthened toward the wrist, and a transverse osteotomy is made near the base of the first metacarpal, and the bone is rotated (See Figure 5).

Step 8. The other half of the transplanted tendon is brought over the extensor muscles of the thumb, and drawn through a small fascial and periosteal tunnel, at the base of the proximal phalanx (See Figure 6).

Step 9. The two ends of the tendons are pulled up quite tightly to hold the thumb in full opposition and are sutured to each other (See Figure 6). The skin incision is closed.

Step 10. The thumb is held with a spiral adhesive strapping for four to six weeks. Active use is encouraged at once (See Figure 7).

DISCUSSION

In the past four years there have been fourteen cases and fifteen operations for opponens paralysis. One was a Bunnell type of free-tendon transplant, together with a capsulotomy at the metacarpophalangeal joint as advocated by Mayer. This worked very well for about a year, but gradually the fixed deformity of the thumb recurred, and the power of opposition was lost.

Two Steindler operations were performed. The result of one of these was quite good, and the patient now plays the piano. She does, however, prefer to write holding the pencil between the second and third fingers. The other Steindler operation was a complete failure, even after two attempts at repair, and the patient has a flexion contracture of the interphalangeal joint.

Two regular Royle operations were done; one is quite satisfactory and the other is poor, possibly because there was too mueh fixed deformity of the thumb.

Nine patients have been operated upon, one on both hands, by the procedure described. One of these had an osteotomy at the base of the

first metacarpal. Of the ten operations, the results of five are rated excellent; three, good; one, fair; and one, poor. In the case rated "poor", the patient fell on the hand about a month after the operation, and since then has lost practically all of the power of opposition which she had had up to that time. In the case rated "fair", the hand was badly paralyzed, and the tendons of the fourth finger were quite adherent. In this case there must have been considerable trauma to the median nerve, as there was a loss of sensation for several months afterward along the median distribution. The position of the thumb is better, and the function of the hand is improved. The results in all of the other cases exceeded expectations.

CONCLUSIONS

The procedure described is a fairly simple, yet efficient, way of restoring opponens power. In the author's experience, it gives better results than the other more complicated methods which have been tried.

REFERENCES

BUNNELL, STERLING: Repair of Nerves and Tendons of the Hand. J. Bone and Joint Surg., X, 1, Jan. 1928.

Opposition of the Thumb. J. Bone and Joint Surg., XX, 269, Apr. 1938.

IRWIN, C. E.: Transplants to the Thumb to Restore Function of Opposition: End Results. Southern Med. J., XXXV, 257, Mar. 1942.

MAYER, LEO: Operative Reconstruction of the Paralyzed Upper Extremity. J. Bone and Joint Surg., XXI, 377, Apr. 1939.

ROYLE, N. D.: An Operation for Paralysis of the Intrinsic Muscles of the Thumb. J. Am. Med. Assn., CXI, 612, 1938.

STEINDLER, ARTHUR: Tendon Transplantation in the Upper Extremity. Am. J. Surg., XLIV, 260, 1939. (Correction, XLIV, 534, 1939.)

SULFONAMIDES IN TRAUMATIC AND INFECTED WOUNDS

A Report of Their Use in Fresh Compound Fractures, Old Compound Fractures with Infection, and Chronic Osteomyelitis.* †

BY LENOX D. BAKER, M.D., DURHAM, NORTH CAROLINA

From the Orthopaedic Division of the Department of Surgery, Duke University School of Medicine, Durham

Frequently new therapies, or adjuncts to old therapies, are introduced in such glamorous terms that, in their acceptance, the underlying principles of surgical treatment are overlooked, resulting in a neglect of the old tried methods and an abuse of the new; the sulfonamides have been no exception to this rule. There can be no question as to their efficacy in certain infections, but, from the following analysis of 121 cases of chronic bone infection and 270 fresh compound fractures, it is apparent that the local use of these drugs is of help in combatting infection only when the fundamental rules of wound hygiene have been followed. Of the 270 fracture cases, 257 were treated within six hours of the injury, nine in six to twelve hours, and four in twelve to twenty-four hours. It seems that one of the dangers in the use of the drugs is the false security one is likely to acquire, at the sacrifice of established surgical principles.

Before the statistics are analyzed, certain facts concerning the actions and relative efficiency of the various sulfonamide derivatives may be an aid in interpreting the findings. It has been shown that small tissue fragments or products of protein hydrolysis in a tissue culture markedly reduce the antibacterial effect of sulfanilamide, as the bacteriostatic action of sulfanilamide is inhibited by the presence of peptone.

Hawking, from his experimental work, concluded that, in dead tissue, sulfanilamide has a higher local concentration and greater powers of penetration and diffusibility, but disappears more rapidly from the wound and has much lower bacteriostatic activity than sulfathiazole, and that tissue with an intact circulation can be reached more quickly and effectively by oral administration.

The work of Dickson, Diveley, and Kiene on the use of sulfathiazole in chronic osteomyelitis, and the laboratory studies of Poston and others, have shown that the thiazole derivative has the highest bacteriostatic effect on the staphylococcus organism.

Sulfathiazole, when used in small amounts and when well distributed throughout the wound, does not appear to interfere with wound healing. When used in too large amounts and when not well distributed, sulfathiazole is more likely to form insoluble concretions which

* Presented at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Atlantic City, New Jersey, January 14, 1942.

† Case reports furnished by members of The American Academy of Orthopaedic Surgeons in reply to a questionnaire.

act as foreign bodies than are sulfanilamide crystals which are more absorbable.

From the general tone of the reports and, in some instances, from definite statements, the sulfonamides apparently do not interfere appreciably with callus formation or bony union, but that point is beyond the scope of this paper, and can be better studied in experiments such as those already so ably carried out by Key and his associates.

This report deals with the use of these drugs under three headings:

1. Fresh compound fractures.
2. Old infected compound fractures.
3. Chronic osteomyelitis.

Originally it was planned to include acute osteomyelitis, but, because of the complexity of the disease and the diversity of the methods of treatment, it was felt that the discussion of the use of the drugs in acute osteomyelitis should be made in a separate report. The use of these drugs in clean operative wounds is not considered, nor is the incidence of gas infection with its various therapies.

FRESH COMPOUND FRACTURES

This series of cases consisted of 270 compound fractures in which one, or more, of the sulfonamides was used locally. In a few of the cases, sulfanilamide and sulfathiazole were combined in the local therapy; in the majority of the group sulfanilamide was used locally in combination with the oral use of sulfathiazole. The relative value of the two drugs is difficult to determine on the basis of these cases; there are too few of them, and the circumstances of their treatment are too variable for a definite conclusion on the marked superiority of any one of the sulfonamides over the others when used locally in traumatic wounds.

Only those cases which were reported individually with definite statements regarding treatment and results are included in the report. Of the 242 fresh compound fractures treated by surgery and the local implantation of sulfanilamide, 192 cases healed without infection; fifty showed some degree of postoperative infection. Sulfathiazole was used in twenty-eight cases. Only three of these showed any postoperative infection; and of these three, one patient was operated upon twelve hours after a previous closure, and, in another, inadequate débridement was admitted by the reporting surgeon. Of 252 cases with primary closure, forty-seven had some degree of postoperative infection, and 205 healed *per primam.* In fourteen cases the wound was packed with vaseline gauze; eleven healed cleanly and three became infected. In four cases postoperative drains were used for twenty-four to forty-eight hours; infection developed in three. Internal fixation was used in 126 cases, of which ninety healed cleanly, and thirty-six became infected; however, seventeen of the thirty-six were reported as healing satisfactorily. Comments on the use of internal fixation in these potentially infected wounds pointed to the advantages of rigid fixation in good alignment, comfort to the patient, and

TABLE I

FRESH COMPOUND FRACTURES

Treatment	Total	Healed	Infected
Open reduction plus chemotherapy	270*	217	53
Sulfanilamide	242	192	50
Sulfathiazole	28	25	3†
Primary closure	252	205	47
Open method	14	11	3
Drained	4	1	3
Internal fixation	126	90	36

* 257 patients were operated upon within six hours; nine, in six to twelve hours; and four, in twelve to twenty-four hours.

† One patient was operated upon twelve hours after previous closure, and one had an inadequate débridement.

ease of applying casts or other types of outside support. Disadvantages also were reported, — such as dead spaces back of ill-fitted plates, separation of the fragments being maintained following absorption at the fracture site, and, in the open or infected cases, failure of the granulation and callus to cover the plates.

The surgical and the supportive treatments in these compound wounds have not been standardized; therefore the statistics do not represent what can be expected when the drugs are used in combination with thorough surgery and ideal supportive care; on the other hand, the favorable aspects of the statistics do not represent what can be expected of the drugs alone.

The results, from the viewpoint of the time elapsed between the injury and the débridement and implantation of the sulfonamide, showed no variation in the percentage of primary healing between the group treated within the first six hours and the group treated within the second six hours. There were only four cases reported in which surgery had been performed after a lapse of twelve hours; all four healed *per primam*. However, these are too few cases to be of any value in judging what can be expected from the therapy in compound fractures treated twelve hours or more following injury.

In correlating the results, it appears that the incidence of infection does not coincide in its entirety with the degree of injury; and that apparently, in many of the cases, the presence of infection is due to the lack of proper débridement and the lack of restoration of normal anatomical relationship, rather than to the type of injury or to the drug used. Previous reports on the incidence of infection in compound wounds have dealt with severe infection, and the percentage of such infection in 852 cases accumulated from the literature ranged from 6.3 to 17.3 per cent. In the 270 cases of fresh compound fractures herein reported, severe infection developed in twenty-seven cases, an average of 10 per cent. The incidence of all infections was 19.6 per cent. This figure is essentially the

same as that reported by Campbell and Smith. In comparing the end results in this series of cases with those reported before the use of this form of chemotherapy, one is impressed by the fact that no operation is more difficult than a débridement and no condition demands keener surgical judgment.

In a compound fracture there are four challenging factors: foreign material, devitalized tissue, the disturbance of the anatomical relationship of the parts, and infection. When properly used, the sulfonamides may help in ridding the wound of only one of these, infection. If the first three factors are not remedied by the surgeon, catastrophe, as seen in some of the cases reported, is frequently the result. The importance of meticulous débridement and thorough wound hygiene has been emphasized in

TABLE II

OLD COMPOUND FRACTURES WITH INFECTION

Treatment	Total	Healed	Infected
Open reduction plus chemotherapy	47	30	17
Sulfanilamide	14	7	7
Primary closure	7	5	2
Open method	7	2	5
Sulfathiazole	33	23	10
Primary closure	20	17	3*
Open method	13	6	7

* All had drains for twenty-four to forty-eight hours.

the reports of the more conservative observers, and many of the communications have contained statements with regard to the necessity of restoration of anatomical relationship and adequate postoperative fixation. It appears that, after these factors have been properly attended to in a painstaking and thorough manner, the presence of a small amount of the sulfonamides is of assistance in abating infection.

The fact that the statistics favor primary closure must be discounted to some extent, as closure of the wound was contra-indicated in many instances because of the definite likelihood of infection, and in some cases because of the avulsion of large areas of soft parts. Whether a wound is closed, or packed and allowed to heal in by granulation tissue and epithelization, is of little ultimate consequence, except from the economic aspect which markedly favors the closed method of therapy.

OLD COMPOUND FRACTURES WITH INFECTION

Reports were received on forty-seven cases of old compound fractures with active infection, which were treated by open reduction and the local implantation of a sulfonamide. In fourteen cases sulfanilamide was used; in seven there was clean healing, and in seven postoperative infection developed. Of the seven healed cases, five were treated by primary

closure and two by the open method. Of the seven infected cases, two were closed and five were packed. Sulfathiazole was used in thirty-three infected old compound fractures. Twenty-three healed, and ten showed some degree of postoperative infection. Of the twenty-three healed cases, seventeen were treated by primary closure and six by the open method. Of the ten infected cases, three were closed and seven were packed.

CHRONIC OSTEOMYELITIS

In the treatment of seventy-four cases of chronic osteomyelitis, in which saucerization, irrigation, implantation of a sulfonamide, and complete closure were carried out, the results are most satisfactory. Fifty-four healed cleanly, and twenty showed some degree of postoperative in-

TABLE III

CHRONIC OSTEOMYELITIS

Treatment	Total	Healed	Infected
Surgery plus chemotherapy	74	54	20
Sulfanilamide	11	7	4
Primary closure	4	4	0
Open method	7	3	4
Sulfathiazole	63	47	16*†
Primay closure	41	36	5
Open method	22	11	11

* Seven later healed. † Three had severe flareups.

fection. However, seven of the cases which were infected healed later, leaving a residual infection in only 16 per cent. of those treated. Sulfanilamide was used in eleven cases, of which seven healed. Of the seven, four were closed following surgery and three were packed with vaseline. The four which showed postoperative infection were all treated by the open method. Sulfathiazole was used locally in sixty-three such cases. Forty-seven healed cleanly, and sixteen showed some degree of postoperative infection. Of the forty-seven cases treated with sulfathiazole which healed, thirty-six were treated by the closed method and eleven by the open. In the sixteen infected cases, five were closed and eleven packed with vaseline gauze. The relative lack of improvement from the addition of the sulfonamides to the open method of treating chronic osteomyelitis, brings up the question as to what result could be obtained in this condition from adequate surgery and complete closure without the drugs.

These drugs challenge us as surgeons, and already because of an increased interest, or because of increased confidence in obtaining primary healing, we are being more thorough in our débridements, more meticulous in our attempts at closure, and as a result more satisfied with our end results. It may well be that these drugs, or one of their derivatives, will

prove of inestimable value as surgical adjuncts; certainly they have brought to light again the necessity for thorough surgery.

Sincere appreciation is expressed to those who have contributed case reports for this study; without their assistance the survey could not have been made.

REFERENCES

1. Campbell, W. C., and Smith, Hugh: Fresh Compound Fractures. Treatment by Sulfonamides and by Internal Fixation in Selected Cases. J. Am. Med. Assn., CXVII, 672, 1941.
2. Dickson, F. D.; Diveley, R. L.; and Kiene, Richard: The Use of Sulfathiazole in the Treatment of Subacute and Chronic Osteomyelitis. J. Bone and Joint Surg., XXIII, 516, July 1941.
3. Hawking, Frank: Local Concentration of Sulphonamide Compounds Inserted into Wounds. Lancet, I, 786, 1941.
4. Herrell, W. E., and Brown, A. E.: Local Use of Sulfamido Compounds in the Treatment of Infected Wounds. Proc. Staff Meet. Mayo Clin., XV, 611, 1940.
5. Key, J. A., and Burford, T. H.: The Local Implantation of Sulfanilamide in Compound Fractures. Its Effect on Healing. Southern Med. J., XXXIII, 449, 1940.
6. Key, J. A.; Frankel, C. J.; and Burford, T. H.: The Local Use of Sulfanilamide in Various Tissues. J. Bone and Joint Surg., XXII, 952, Oct. 1940.
7. Key, J. A., and Frankel, C. J.: The Local Use of Sulfanilamide, Sulfapyridine and Sulfamethylthiazole. Ann. Surg., CXIII, 284, 1941.
8. Poston, M. A.: Personal Communication.

ACUTE HEMATOGENOUS OSTEOMYELITIS IN THE ADULT

BY JACK E. MAXFIELD, M.D., AND C. LESLIE MITCHELL, M.D.,
DETROIT, MICHIGAN

From the Division of Orthopaedic Surgery, Henry Ford Hospital, Detroit

Acute primary or hematogenous osteomyelitis in the adult is a relatively uncommon disease which should be considered a separate clinical entity. There are only two papers in the literature which deal with this subject in any detail. Zadek and Leclerc have both given case reports and discussions. Other than these, one can find only isolated case reports and comments given incidentally with large series of childhood cases. Of particular interest in this connection is Butler's report of 500 cases of which forty-five were in adults.

The authors have observed five cases of the acute disease in adults in the past three years, and feel that they present some features which are worthy of emphasis.

In the case reports to follow, it will be noted that the symptomatology of the adult disease is strikingly different from that of the childhood type. The onset is a matter of weeks or even months, the pain is vague and may shift location from day to day. The pathology is most apt to appear near the center of the diaphysis. Although the patient may have considerable fever, there is usually very little toxicity.

CASE REPORTS

CASE 1. P. V., a white male, twenty-four years old, was first seen on May 3, 1939, complaining of throbbing pain in the left knee of one week's duration. There were no local findings and roentgenograms of the knee and hip were negative. By May 23 there was tenderness, local heat, and swelling in the mid-thigh, with leukocytosis of 15,400, and temperature of 103 degrees. Roentgenograms of the femur (Fig. 1-A) showed light periosteal reaction with a suggestion of localized osteoporosis in the medullary cavity. An osteotomy was done, and considerable pus escaped under pressure from the central canal. A culture showed staphylococcus aureus. On the seventh postoperative day, a pathological fracture occurred while the patient was getting on a bed pan (Fig. 1-B). Progress was slow, with repeated acute exacerbations of infection, but union of the fracture was obtained.

CASE 2. J. R., a negro male, twenty-one years old, was first seen on September 10, 1941, complaining of "charley-horse" in the right thigh of three weeks' duration. There was tenderness, induration, and deep-seated swelling over the lower right thigh. Temperature was 103 degrees, and white blood count was 11,000, but the patient did not appear ill. Roentgenograms of the femur showed a minimal amount of light, periosteal reaction (Fig. 2-A). Treatment consisted in chemotherapy, drilling of the femur with the escape of staphylococcus pus, packing of the wound, and application of a long leg cast. On the twenty-third postoperative day the patient put weight on the cast and fractured the femur through the diseased area (Fig. 2-B). There continued to be marked destruction of the femoral shaft, and the development of abundant callus (Fig. 2-C). The wound is still draining and two tiny sequestra have been removed.

FIG. 1-C

Case 1. P. V. Showing extensive involvement a few weeks after diagnosis.

FIG. 1-B

Case 1. P. V. Showing pathological fracture.

FIG. 1-A

Case 1. P. V. Anteroposterior roentgenogram of the femur showing faint periosteal reaction at the lower right.

FIG. 2-C

Case 2. J. R. Showing extensive involvement of femoral shaft.

FIG. 2-B

Case 2. J. R. Showing pathological fracture.

FIG. 2-A

Case 2. J. R. Anteroposterior roentgenogram of the femur upon which diagnosis was made.

FIG. 3

Case 3. J. G. Tibia after window had been made. Note the location of the lesion in the diaphysis.

CASE 3. J. G., a white male, sixty-two years old, had had a drainage of an appendiceal abscess on January 27, 1940, and an excision of a carbuncle on his back on May 22, 1940, with a positive blood culture for hemolytic staphylococcus a few days later. On or about June 10, he began to have pain near the upper end of the left tibia, but his temperature and leukocyte count remained normal. The tibia was drilled, and a small amount of pus was found, on June 17. In spite of adequate drainage and extensive chemotherapy, the blood culture remained positive, and the patient expired on July 11, 1940. Figure 3 shows the diaphyseal position of the lesion, after a window had been cut at a second operation.

CASE 4. E. M., a white male, twenty-nine years old, was first seen on November 19, 1940, with a history of intermittent pain in the left arm for four years, with continuous pain, more severe in the past three months. He had already had two neurosurgical operations on the arm at another hospital in an attempt to relieve the pain. There was moderate atrophy of the arm, with tenderness and definite thickening of the mid-portion of the humerus. Temperature was 99.6 degrees and white blood count was 16,000. Roentgenograms of the humerus showed widening of the cortex, with expansion of the medullary cavity into cystlike areas, and some new periosteal reaction (Fig. 4). Complete healing occurred two months after saucerization of the bone.

CASE 5. J. A., a white male, twenty-nine years old, was first seen on October 3, 1938, complaining of pain in the right groin of three weeks' duration. Another physician had made a diagnosis of "rupture". There was tenderness in the groin, a leukocytosis of 15,900, and a temperature of 99.4 degrees. Roentgenograms of the hip showed a cystlike area in the upper femoral shaft, with a surrounding, marked periosteal reaction (Figs. 5-A and 5-B). The patient was operated upon elsewhere, and pus was found in the femur.

DISCUSSION

There are two features of special interest in these cases,—namely, the variation in the roentgenographic findings, and the complication of pathological fracture in the two femora. It is to be noted that the first films in each case showed a light periosteal reaction, which is believed to be the chief diagnostic feature. Cases 1, 2, and 3 showed only this reaction. The last two patients, however, had, in addition, one or more central areas of rarefaction which may be interpreted as bone abscesses. (See Figures 4, 5-A, and 5-B.) Whether these

central abscesses may have been present long before the occurrence of the acute episode or not, the authors have not been able to determine with certainty, but it seems probable that in Case 4, such a low-grade infection might have accounted for the patient's intermittent pain over a four-year period. In any event, the end picture is not that of a typical Brodie's abscess as described by Brailsford, and Wagner and Hanby. A Brodie's abscess does not show light periosteal reaction; the abscess has bone sclerosis around its margin, and the location is characteristically near the epiphysis rather than in the center of the diaphysis. It is suggested that there may be two distinct pathological types of acute hematogenous osteomyelitis in adults,—Type I, in which there is a primary periosteal involvement with secondary invasion of the medullary shaft, and Type II, in which the infection is primarily a low-grade one in the central area, with secondary spread to the periosteum. In the latter type, the symptoms do not become relatively acute until the time of the periosteal invasion and reaction.

FIG. 4

Case 4. E. M. Anteroposterior roentgenogram of the humerus, showing cystic medullary change and surrounding periosteal reaction.

Regarding the complication of pathological fracture in infections of the femoral shaft, numerous isolated examples may be found in the papers of Zadek, Leclerc, Hobart and Miller, Mitchell, and Butler. The occurrence of the fracture is probably directly related to the extensive destruction of the femur by the infection (Figs. 1-C and 2-C), rather than to any particular type of surgery. It should be emphasized that the fracture can occur with a minimal amount of trauma, and that a leg cast will not prevent it. The authors feel very strongly that all cases in adult femora should be treated from the beginning in plaster hip spicas, or their equivalent, in an attempt to prevent this serious complication.

FIG. 5-A

Case 5. J. A. Anteroposterior roentgenogram of the upper femur, showing cystic change.

FIG. 5-B

Case 5. J. A. Lateral view of the upper femur, showing periosteal reaction posteriorly.

SUMMARY

Two of five cases of acute, hematogenous osteomyelitis in the adult occurred in the femoral shaft, and were accompanied by pathological fractures—which are a common occurrence and difficult to prevent.

The clinical pictures of adult and childhood osteomyelitis are different.

There may be two distinct pathological types of adult infection, as evidenced by roentgenograms.

REFERENCES

BRAILSFORD, J. F.: Brodie's Abscess and Its Differential Diagnosis. British Med. J., II, 119, 1938.

BUTLER, E. C. B.: The Treatment, Complications, and Late Results of Acute Haematogenous Osteomyelitis Based on Study of 500 Cases Admitted to London Hospital During Years 1919–37 (Hunterian Lecture, Abridged). British J. Surg., XXVIII, 261, Oct. 1940.

HOBART, M. H., AND MILLER, D. S.: Osteomyelitis at Cook County Hospital, with Appraisal of Orr's Method of Treatment. J. Am. Med. Assn., CVII, 1118, 1936.

LECLERC, GEORGES: A propos de quelques aspects de l'ostéomyélite primitive de l'adulte. Rev. d'Orthop., XXV, 227, 1938.

MITCHELL, J. I.: Acute Osteomyelitis. Etiology, Symptoms, Diagnosis and Treatment of Eighty Cases. Southern Med. J., XXIX, 588, 1936.

WAGNER, L. C., AND HANBY, J. E.: Brodie's Abscess. Pain Distribution, Occurrence and Diagnosis. Am. J. Surg., XXXIX, 135, 1938.

ZADEK, ISADORE: Acute Osteomyelitis of the Long Bones of Adults. Arch. Surg., XXXVII, 531, 1938.

EPIPHYSEAL PSEUDARTHROSIS *

BY HENRY MILCH, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases, New York

Separation of epiphyses may occur as the result of trauma or as the consequence of a pathological process directly affecting the growing zone. In general, provided that excessive separation has not occurred, union, and even premature closure of the epiphyseal line, follows upon disappearance of the factors which caused the separation. Under certain circumstances, however, fusion may not take place, and a condition which may be called epiphyseal pseudarthrosis, or nearthrosis, arises. It has usually been considered as an interesting, but annoying, complication of infections or operative procedure about the hip joint. The writer's attention has been recently redirected to the study of septic hips by Badgley, Yglesias, Perham, and Snyder, which appeared in 1936. Their Table XI showed that among the complications were:

"Epiphysiolysis (produced by traction in 2 cases)... 9 cases
Nearthrosis (at epiphyseal line with fusion of head to acetabulum or ilium)..... 8 cases"

Beyond this, but little attention has been devoted to the discussion of this condition in available medical literature, and no explanation of the pathogenesis of the condition has been found. This is the more to be regretted, because recognition of the condition may be of some value in explaining both the apparent failure of certain hip fusions, and the mechanism of development of so-called coxa anteverta,—the early phase of adolescent epiphyseal separation at the upper end of the femur [3].

Occasionally, epiphyseal pseudarthrosis has been observed at the inferior femoral epiphysis, following ankylosis of the knee [7]; but most commonly it is found at the upper femoral epiphysis. Though the particular circumstances under which the condition appears may be different in the individual cases reported, the clinical picture in all seems to be dominated by certain common factors,—fixation of the epiphysis before closure of the epiphyseal line, and relative motion of the femoral shaft.

CASE I. R. B. (Case of Harry Sonnenschein, M.D.) has been under treatment for chronic osteomyelitis since the age of eleven (about 1917). At that time the child had suffered an infection of the right hip, which had been treated at another institution. Following this, the patient had suffered a recurrence for which treatment had been instituted. At the age of twenty-five, the infection in the lower end of the right femur had flared up. In 1937, at the age of thirty-one, the left hip became involved. In 1938, following an injury, symptoms appeared in the right knee. In 1941, the patient was again admitted for an acute exacerbation at the upper part of the right thigh.

Examination, clinically and roentgenographically, disclosed firm ankylosis of the left hip. On the right side, however, flexion of 30 degrees, abduction of 15 degrees, external rotation of 35 degrees, adduction of 5 degrees, and internal rotation of 7 degrees

* Presented before the Clinical Society of the Hospital for Joint Diseases, New York, N. Y., November 18, 1941.

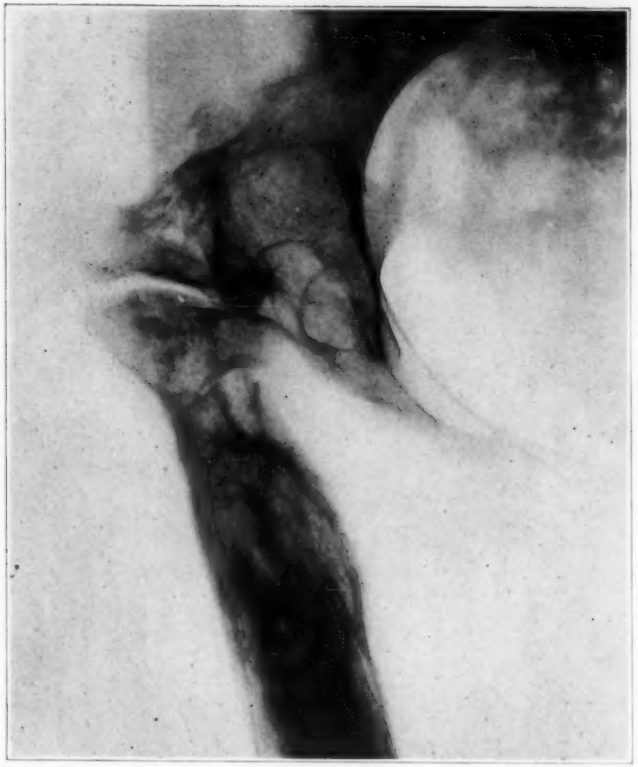

FIG. 1-A

Case 1. R. B. The femoral head is ankylosed to the ilium. The margins of the epiphyseal line are smooth and sclerotic. The thigh is in adduction.

FIG. 1-B

Case 1. R. B. The thigh has been brought into abduction. The head is fixed and the site of motion is indicated by a widening of the epiphyseal line.

were noted. The roentgenogram (Fig. 1-A), disclosed ankylosis of the right femoral head, with a nearthrosis in the region of the old epiphyseal line. The margins of the nearthrosis were smooth and somewhat sclerotic. On abduction, the location of the motion was indicated by widening of the pseudarthrotic space (Fig. 1-B).

In consideration of the bony ankylosis which occurred later at the left hip, the pseudarthrosis on the right side must be looked upon as a particularly fortunate circumstance. From the history of the case, it would appear that the outcome must be predicated upon the belief that the ankylosis on the right side occurred before the epiphyseal plate had closed, while on the left side the ankylosis was coincident with, or took place after fusion of the epiphyseal plate. Special attention should be directed to the pyramidal shape of the capital epiphysis, which may resemble the result of a satisfactory shelf operation in a movable hip. If this is not recognized, the possibility of pseudarthrosis at the epiphyseal line may be overlooked. The following case is interesting from this point of view.

CASE 2. D. S. was first seen in the Hospital in 1929, at the age of two years. During the preceding year the patient had been immobilized in a plaster-of-Paris spica for a limp in the left hip. On admission there were characteristic clinical and roentgenographic signs of tuberculosis of the hip, and the treatment by plaster-of-Paris immobilization was continued. In January 1934, an extra-articular fusion of the hip was undertaken. In June 1935, a flexion-adduction deformity of the left hip necessitated the performance of a *directional* osteotomy. In January 1938, it was noted that flexion of the thigh was possible to 110 degrees and abduction to 10 degrees. This was attributed to failure of the fusion operation.

In February 1937, following a fall several hours earlier, the patient returned to the Hospital, complaining of pain in the right hip. A diagnosis of acute separation of the capital epiphysis was made. Under general anaesthesia, what appeared to be an anatomical reduction was accomplished, and a double spica was applied. Nevertheless, upon roentgenographic check-up, an incomplete correction of the deformity was noted, and a second unsuccessful attempt at manipulative reduction was made. The patient was fitted with an internal-rotation brace and was discharged, walking[4]. At this time, extension of the hip to 180 degrees and flexion to 90 degrees was possible. A roentgenogram taken in March 1939 disclosed calcification of the epiphyseal plate on the right side. The left hip was described as disclosing an old destructive arthritis, with dislocation and the presence of a *bone bridge* superiorly. The upper end of the left femur and what was thought to be the joint space, are seen in Figure 2-A.

In July 1938 the patient again complained of pain in the left hip. Flexion of the femur was possible to 100 degrees and extension to 140 degrees. No rotation could be obtained, but abduction was present to 10 degrees. Clinically, there appeared to be motion in the left hip, but the tuberculous lesion did not appear to be progressing, either clinically or roentgenographically. Bed rest was advised, but, contrary to what might have been expected, the pain became worse. In January 1939, a roentgenogram showed essentially the same appearance as had been noted the previous March. When these roentgenograms were attentively studied, it was observed that the bone bridge described in the earlier roentgenogram really consisted of the fused femoral head. The site of motion was obviously in the subcapital region, and the neck of the femur pointed forward. In view of the epiphysiolysis which had developed on the right side, it seemed likely that the patient had developed an epiphysiolysis on the left side, but that, as a result of the fixation of the femoral head, a pseudarthrosis had developed at the epiphyseal line.

FIG. 2-A

Case 2. D. S. March 9, 1939. The fusion of the head into the acetabulum is to be noted. The epiphyseal line appears to be open.

FIG. 2-B

Case 2. D. S. December 1940. Following a pelvic-support type of osteotomy to limit motion, the epiphyseal line is partially fused. All hip motion and all symptoms have disappeared.

In March 1940, because of the underlying tuberculous disease, it was decided that an angulation *pelvic-support osteotomy* should be performed to limit motion[5]. The limb was immobilized in plaster for a period of four months. Subsequently all pain disappeared, even on weight-bearing. A roentgenogram (Fig. 2-B), taken in December 1940, showed union at the site of the osteotomy, with solid closure of the epiphyseal line. In April 1941, no motion at the left hip could be obtained.

In retrospect, this case seems to merit special attention. The patient was definitely not of endocrine *habitus*, and the epiphyseal separation on the right side appeared only after the fusion of the left hip,—possibly as a result of the additional stress caused by the hip tuberculosis on the left. On the right side, the relative limitation of external rotation accomplished by the brace was sufficient to lead to fusion at the epiphyseal line. On the left side, where the head was fused to the acetabulum, closure of the epiphyseal plate occurred only after osteotomy. It would appear, therefore, that two elements—motion of the head and motion of the shaft—enter into the pathogenesis of the condition. With regard to the joint line, motion between the head and pelvis is of critical significance; but, with regard to the epiphyseal line, it is the motion of the shaft relative to the head which is important. Such relative motion may occur against an ankylosed head, or against a movable, but relatively fixed, head. In the latter instance, it may lead to epiphysiolysis; in the former, to epiphyseal pseudarthrosis.

Other observers have noted the occurrence of motion in adolescent hips previously submitted to fusion operations. For the most part, the persistence of motion has been attributed to failure of fusion, and operative revision has not infrequently been advised and performed. The possibility that motion may develop at the epiphyseal line, after fusion of the head to the pelvis, does not seem to have been adequately stressed. However, recognition of the fact that such a condition may develop after an otherwise properly conducted fusion operation is of the utmost importance. Primarily, it indicates that opinion as to the success or failure of the operative fusion must be deferred until the site of motion can be accurately located. If it can be established that the motion takes place between the femoral head and the neck, it may be presumed with reasonable assurance that fixation, if not complete bony fusion of the head, has occurred at the joint line.

Since the existence of the pseudarthrosis must be predicated upon motion of the distal part, with respect to the relatively fixed proximal portion of the femur, certain indications with regard to treatment and prophylaxis of the condition appear evident. With regard to treatment of the condition, it seems that immobilization of the distal fragment is essential. Whether this be accomplished by plaster-of-Paris encasement, by drilling, by nailing, or by osteotomy may be immaterial, provided the fixation is maintained until closure of the epiphyseal line has occurred. With regard to the prophylaxis of the condition, it would appear that when fusion is indicated in the adolescent, intra-articular fusion alone

may be inadequate. Unless some means is provided for fixing the shaft until bony union has occurred between the capital epiphysis, the pelvis, and the upper end of the femur, the possibility of a pseudarthrosis developing cannot be confidently denied. This would seem to argue in favor of the combined intra-articular and extra-articular types of fusion in patients below the age of epiphyseal closure.

In both the cases above reported, it is to be noted that the pseudarthrosis was conditioned by mobility of the shaft and immobility of the capital epiphysis, but the full significance of fixation of the head was not completely appreciated until the following case was reviewed.

CASE 3. I. H. Was first seen in 1935, at the age of eleven years, with an epiphysiolysis of the *right hip* (previously reported)[3].

"In February 1936, the child began to complain of pain in the left knee. Clinical examination disclosed no evidence of any limitation of motion, either in the knee or in the hip. A roentgenogram, taken on February 24, 1936, was reported as being 'radiographically negative.'

"On April 13, 1936, . . . the pain in the left hip was becoming more severe, and . . . a slight [hip] limp was noticed. Examination revealed no limitation of motion, but the roentgenogram . . . was reported as showing 'slight resorption of the neck of the femur adjacent to the epiphyseal line', . . . There is no slipping of the epiphysis at this time, but the x-ray is suspicious of early slipping."

Five days later a clinical diagnosis of acute epiphyseal separation was confirmed by roentgenogram.

Because of the recent nature of the displacement, closed reduction under general anaesthesia was undertaken. Roentgenograms taken at the time seemed to indicate satisfactory alignment, and a plaster-of-Paris spica was applied. Upon removal of the plaster, the epiphyseal plate *appeared* to be closed, but the hip had become completely stiff. In an effort to restore mobility, the thigh was manipulated under anaesthesia. A moderately satisfactory range of motion, presumably at the hip joint, was obtained. In an effort to increase this, a fracture of the lower end of the femur was incurred. Plaster was reapplied until healing of the femoral fracture had occurred; then an internal-rotation brace was applied, and the patient was permitted to walk.

In March 1937, it was noted that flexion of the left thigh was possible to 135 degrees; extension, to 150 degrees; internal rotation, to 20 degrees; external rotation, to 10 degrees; and abduction, to 20 degrees. Roentgenograms taken at this time showed no evidence of closure of the epiphyseal line. In fact, it appeared that the "satisfactory range of motion" previously accomplished had been obtained by reproducing the acute epiphysiolysis. In April 1938, the roentgenogram (Fig. 3-A) showed "moderate eburnation of the femoral neck at the original epiphyseal line. The capital epiphysis appears to be fused to the acetabulum."

In 1939, because of the persistence of pain and disability, a transpositional type of pelvic-support osteotomy [5] was performed. Physiotherapy was instituted, and walking with the aid of crutches was permitted as soon as bony healing of the osteotomy had occurred. After several months, the most startling results were noted. The pain had disappeared, the gait had improved, and motion at the hip, appeared to be gradually returning. In December 1940 the patient could flex the hip to 70 degrees, extending it to 180 degrees, and abduct it to 25 degrees. External rotation was possible only to 5 degrees and internal rotation to 20 degrees. The roentgenogram showed "complete bony union at the site of the previous bifurcation osteotomy of the femur, with good alignment of the fragments. The femoral neck is moderately increased in width and is somewhat irregular. There is slight narrowing of the hip joint proper." But the most startling of all was that the epiphyseal line had closed by bony union and the pseudarthrosis had completely vanished (Fig. 3-B).

FIG. 3-A

Case 3. I. H. April 6, 1938. The head *seems* to be fixed in the acetabulum. The open epiphyseal line is to be seen. At the epiphyseal plate, the bone surfaces are sclerotic and rounded, and present the appearance characteristically seen in other pseudarthroses.

FIG. 3-B

Case 3. I. H. December 6, 1940. Following transposition osteotomy, the epiphyseal line has been closed by bony union. There is no fusion of the head to the acetabulum.

No specimen was removed, and the diagnosis of epiphyseal pseudarthrosis necessarily rests upon the clinical examination, and the roentgenographic appearance of the condition. However, the cupping of the capital epiphysis, and the rounding and sclerosis of the upper end of the femoral neck were so characteristic of the appearance seen in other types of pseudarthrosis that the diagnosis appeared amply justified. This seemed the more likely in view of the fact that, in specimens of the cartilage plate removed from other patients with adolescent epiphysiolysis, histological evidence suggesting the early phase of pseudarthrosis formation has been found [2].

The fact that motion at the hip persisted after union had occurred at the epiphyseal line seemed to indicate that the pseudarthrosis had taken place between a movable shaft and a *relatively* fixed femoral head. The fact that at one time the head appeared fused to the acetabulum and the epiphyseal line was open, while at another the epiphyseal line appeared closed and the head was clearly free, suggests that the characteristic appearance of pseudarthrosis seen at the upper end of the neck of the femur betrayed this to be the site of motion. Naturally enough, the possibility of applying this concept of relative fixation to adolescent epiphysiolysis presented itself.

A number of different hypotheses have been advanced to explain adolescent epiphysiolysis. At the present time, informed opinion attributes the condition to forces which may be roughly classified as those which amplify external rotation of the shaft (such as overweight, trauma, or increasing obliquity of the epiphyseal plate), and those which decrease the resistance of the cartilage plate (such as endocrine or other metabolic disturbances). Whichever one of these etiological factors may be considered as *the* cause of epiphysiolysis, none seems to offer a completely satisfactory account of the pathogenesis of the condition. It has been realized that any valid description of the mechanism would have to include a force which would act upon the head, in a direction contrary to that made necessary by the progressive anteversion of the upper end of the femoral neck. In an attempt to remedy this defect, the resistance of the ligamentum teres femoris has been cited as a counterforce. This does not appear to have made a deep impression upon those interested in a solution of the problem of epiphysiolysis. It has seemed highly probable that, if any anatomical interference with motion of the femoral head contributed to the development of epiphysiolysis, it would have to be of greater magnitude than the resistance offered by the ligamentum teres femoris.

The existence of such a force was brought to the writer's attention during a demonstration of the anatomy of the hip joint. The iliopsoas tendon is described as lying over the capsular ligament of the hip joint,—that is, presumably over both the head and neck of the femur. However, when the relationship of this tendon was attentively examined, it was found to lie quite specifically over only the descending arm of the

Y ligament of Bigelow. In over twenty cadavera in which this joint was investigated, the tendon was found to have made a longitudinal groove in the capsule, but this was always confined to a narrow area along the medial portion of the capsule. In no instance was the tendon found to cover the neck of the femur. In external rotation, when the anterior portion of the head was directed forward, the tendon lying upon the descending arm of the capsule covered only the area of the original capital epiphysis. Lateral to this, the neck of the femur was covered by the capsule, which arched across from the region of the head to its insertion near the base of the femoral neck.

When the extended thigh was externally rotated, the femoral head moved partly out of the acetabulum, pushing before it the iliopsoas tendon. The limit of external rotation appeared to be determined by the tension of the iliopsoas tendon and not by the capsule, which was still relaxed when motion was checked. It was only after the iliopsoas tendon was cut across, that further external rotation was possible up to the point where the pubofemoral portion of the capsule became taut. At this limit there was, between the anterior portion of the neck and the taut capsule, a space within which further motion of the separated neck easily would have been possible, even after all forward motion of the head had been stopped.

This disposition of the psoas tendon offered a rational anatomical explanation for the development of the counterforce necessary in the pathogenesis of epiphysiolysis. Viewed as a mechanism for relative fixation of the femoral head, it served to establish a correlation between epiphysiolysis and epiphyseal pseudarthrosis[6]. Both occur before the epiphyseal line closes, and both are characterized by mobility of the long lever arm of the femoral shaft against a relatively immobilized capital epiphysis. Both can be cured by immobilization of the shaft with respect to the capital epiphysis. In fact, it appeared not unreasonable to consider epiphyseal pseudarthrosis as a chronic form of the condition more commonly seen as adolescent epiphysiolysis.

SUMMARY

Epiphyseal pseudarthrosis at the hip has been observed under the following conditions:

1. After operative fusion of the hip,
2. After inflammatory ankylosis of the hip,
3. As a sequel to adolescent epiphysiolysis.

It may occur in any condition in which the capital epiphysis becomes ankylosed before closure of the epiphyseal plate occurs. Mechanically, mobility of the shaft of the femur, with respect to a *relatively* fixed head, is essential to the appearance of the condition. Successful therapy is based upon immobilization of the distal fragment in relation to the proximal fragment.

Recognition of the condition is of paramount importance in explain-

ing some cases of apparent failure after an attempt at operative fusion of the hip. Appreciation of its cause throws interesting light on the pathogenesis of adolescent epiphysiolysis.

REFERENCES

1. Badgley, Carl; Yglesias, Luis; Perham, W. S.; and Snyder, C. H.: Study of the End Results in 113 Cases of Septic Hips. J. Bone and Joint Surg., XVIII, 1047, Oct. 1936.
2. Jaffe, H. L.: Personal communication.
3. Milch, Henry: Epiphysiolysis or Epiphyseal Coxa Anteverta. J. Bone and Joint Surg., XIX, 97, Jan. 1937.
4. Milch, Henry: Internal-Rotation-Brace Treatment of Epiphyseal Coxa Anteverta (Early Epiphysiolysis). J. Bone and Joint Surg., XXI, 752, July 1939.
5. Milch, Henry: The "Pelvic Support" Osteotomy. J. Bone and Joint Surg., XXIII, 581, July 1941.
6. Müller, Walther: Experimentelle Untersuchungen über mechanisch bedingte Umbildungsprozesse am wachsenden und fertigen Knochen und ihre Bedeutung für die Pathologie des Knochens, insbesondere die Epiphysenstörungen bei rachitisähnlichen Erkrankungen. Bruns' Beitr. z. Klin. Chir., CXXVII, 251, 1922.
7. Pomeranz, M.: Personal communication.

LEGG-PERTHES DISEASE

A Comparative Study of Various Methods of Treatment

BY LOUIS J. LEVY, M.D., FORT WORTH, TEXAS, AND
P. M. GIRARD, M.D., DALLAS, TEXAS

From the Texas Scottish Rite Hospital for Crippled Children, Dallas

In 1909, Legg first described epiphysitis of the femoral head as a clinical entity. Since that time the treatment of choice has been a subject of considerable controversy. The very fact that there have been so many different methods of treatment described, reveals the lack of unanimity of thought on the subject. In an attempt to evaluate the various methods of therapy, 102 cases of Legg-Perthes disease were analyzed. Eleven of these cases were bilateral, so that in all a total of 113 hips were studied.

In analyzing the results of treatment, both clinical and roentgenographic findings were taken into consideration. The roentgenographic results were found to be the more reliable criteria. Early in the course of the disease, the symptoms are often more marked than the roentgenographic changes would warrant, whereas in the healed condition, a good clinical result is frequently associated with a poor roentgenographic result. Often in a patient showing a good clinical, but a poor roentgenographic result, limitation of motion and pain from traumatic arthritis will develop at a later date; or painful instability may develop. For this reason, in the evaluation of these cases, more credence has been given to the roentgenographic results than to the immediate clinical results.

The roentgenograms were studied for the amount of flattening and fragmentation of the head, and the amount of broadening of the neck. The most essential evaluating factor was found to be the amount of flattening, but, in the final analysis, this had to be qualified with a note concerning the regularity and shape of the head.

The cases were divided into eight groups according to the type of treatment each received. Six of the cases were treated by miscellaneous methods not fitting into any of the larger categories, so the total number discussed and tabulated is ninety-six. Each of the eight groups will be discussed separately:

1. *No Treatment*

There were sixteen patients in this group, who were either not seen until after the disease had completely healed, or who were followed through the course of the disease with no treatment being instituted. These, for the most part, are patients who were seen near the beginning

TABLE I

RÉSUMÉ OF RESULTS OF TREATMENT

Type of Treatment	No. of Cases	Average Height of Head as Compared with the Normal (*Per Cent.*)			Clinical Results (*Per Cent.*)				Duration of Phases (*Months*)	
		When Therapy Started	At Maximum Destruction	In Final Results	Excellent	Good	Fair	Poor	Degenerative	Regenerative
1. None	16	100	42	48	0	19	25	56	23	16.5+
2. Brace	21	60	42	53	9.5	9.5	48	33	16	17
3. Brace and elevated shoe	10	81	52	54	0	40	20	40	21	20
4. Cast, brace and elevated shoe	4	54	53	59	25	50	25	0	18	19.5
5. Drilling, cast, brace, and elevated shoe	8	44	45	57	12.5	62.5	12.5	12.5	16	15
6. Cast	9	57.5	38	38	0	11	22	67	19	21
7. Cast and brace	13	61	49	55.5	15.5	23	38.5	23	16.5	16.5
8. Elevated shoe and crutches	15	64	50	60	13.3	53.4	20	13.3	16	16

of the series when it was felt that treatment did not materially alter the course or result of the disease.

In presenting these cases, the original condition of the head must be considered as normal (100 per cent.). At the point of maximum destruction, the head was only 42 per cent. of its original height, and in the final result it had regenerated to only 48 per cent. of its normal height. No patient in this group had an excellent result. The results were good in 19 per cent., and fair in 25 per cent. In 56 per cent., the broadening, distortion, and irregularity of the head gave poor results (Table I).

In the clinical classification of these cases, *excellent* refers to those patients of whom the roentgenogram shows a femoral head with at least 70 per cent. of its normal height, and who had full range of motion of the hip clinically, no shortening of the leg, and no pain. *Good* results were in those with well-rounded heads of at least 50 per cent. of normal height, and who clinically had less than one centimeter of shortening, only slight limitation of motion, and no pain or instability. The *fair* results were in those in whom the head was less than 50 per cent. of normal height, not well rounded, and showing roentgenographic evidence of possible instability later, in spite of a clinically stable hip at the time of examination. In this group, the shortening was less than two centimeters. Hip motion was at least 50 per cent. of normal, with only occasional slight pain on weight-bearing. The *poor* results were in those in whom the roentgenograms showed marked flattening and distortion of the head, a sloping acetabulum with evident instability, or a lateral prominence of the head requiring reconstruction. Although many of these patients with poor roentgenographic results may show good clinical results immediately after healing, it has been found that a gradual limitation of motion will usually develop. Traumatic arthritis and increasing pain and instability will appear later in life.

In the group of cases which had no treatment, the degenerative phase (length of symptoms plus length of time under treatment until regeneration began) was twenty-three months. Since many of the cases in this group were seen for the first time late in the course of the disease, figures for the duration of the regenerative phase are inaccurate. From data obtainable, however, it is evident that this phase is well in excess of sixteen and one-half months.

2. *Brace*

Twenty-one patients were treated with a brace of the Thomas-ring, caliper type, with frequent adjustments to try to maintain ischial weight-bearing. The findings coincide with those of other writers [5], that this is a very inadequate type of treatment. When the average patient of this group was first seen, the femoral head was 60 per cent. of normal height. During the degenerative phase, the head was flattened to 42 per cent., and the final result showed the head to be 53 per cent. of normal height. The results were excellent in 9.5 per cent.; good, in 9.5 per cent.; fair, in 48 per

cent.; and poor in 33 per cent. (Table I). In this group, the average degenerative phase lasted sixteen months, and the regenerative period required seventeen months.

3. *Brace and Elevation of the Opposite Shoe*

Ten patients were treated with a non-weight-bearing brace on the involved leg and an elevated shoe on the opposite foot. The brace was of the ischial-ring, weight-bearing type. The side bars of the brace were extended to a walking sole two to three inches beyond the foot on the involved side, so as to prevent weight-bearing on the femoral head. The opposite shoe was elevated accordingly. The results in this group were very similar to those obtained by treatment with a brace only. The average case was seen fairly early, with the femoral head 81 per cent. of normal height. During the course of treatment, the flattening progressed until the head was 52 per cent. of normal, and improved only to 54 per cent. In this group no patient could be said to have an excellent result. In 40 per cent. the results were good; in 20 per cent., fair; and in 40 per cent., poor. The degenerative phase lasted twenty-one months. The follow-up results in this group were too incomplete for definite figures, but the regenerative phase was approximately twenty months.

4. *Cast, Brace, and Elevation of the Opposite Shoe*

Four of the patients were treated with a spica cast for four months; this was followed by a non-weight-bearing brace on the involved leg and an elevated shoe on the opposite foot. Although the number of cases in this group was quite small, the significance of it must be considered. By merely adding a preliminary period of immobilization and rest, the treatment by brace and shoe-elevation (as in Group 3) gave much better results. The initial height of the femoral head in the average case was 54 per cent. of normal. The head flattened to 53 per cent., and improved to 59 per cent. The final clinical results were excellent in 25 per cent. of the cases; good, in 50 per cent.; and fair, in 25 per cent. None of the patients had poor results. The degenerative phase lasted eighteen months, and the regenerative phase was nineteen and one-half months (Table I).

5. *Drilling, Cast, Brace, and Elevation of the Opposite Shoe*

Eight patients were treated by multiple subcutaneous drilling through the neck into the femoral head, as described by Bozsan.[1,2] This was followed by a spica cast for four months, after which a non-weight-bearing brace was applied to the involved leg, and an elevated shoe to the opposite foot. Most of the patients selected for this type of treatment had considerable head destruction when first seen. The average femoral head in this group at onset of treatment was only 44 per cent. of normal height. Under this regime, flattening progressed only to 43 per cent., and improved until the head was 57 per cent. at the end of the regenerative phase. The clinical results were excellent in 12.5 per cent. of the cases;

good, in 62.5 per cent.; fair, in 12.5 per cent.; and poor, in 12.5 per cent. The degenerative phase lasted sixteen months, and the regenerative phase, fifteen months (Table I).

6. *Cast*

Nine of the earlier patients in this series were treated by recumbency in plaster casts. The patients were placed at bed rest in a spica cast for a period of time varying from two to eight months, after which they were allowed up with crutches with gradually increasing weight-bearing. At the time this treatment was used, it was intended more to relieve the initial muscle spasm and clinical signs than to furnish a method of insured rest and immobilization until the head had regenerated. For this reason, few of these cases had advanced very far into the regenerative phase when weight-bearing was resumed. During the period of recumbency, the femoral heads usually retained their height and structure fairly well. As soon as activity was resumed, however, flattening and destruction rapidly occurred. In the average case, the femoral head was 57.5 per cent. of normal height when first seen. During the course of treatment flattening progressed until the head was only 38 per cent., and improved practically none from this point. The final clinical and roentgenographic results were very unsatisfactory: No patient had an excellent result. The results were good in 11 per cent.; fair, in 22 per cent.; and poor, in 67 per cent. The degenerative phase lasted nineteen months, and the regenerative phase lasted twenty-one months (Table I).

7. *Cast Followed by Brace*

This group of thirteen patients were treated by recumbency in a plaster spica for an average period of four months, after which a Thomas-ring, caliper type of brace was applied to the involved leg. The results obtained were intermediate between those with a cast alone, and those which were treated with a cast followed by a non-weight-bearing brace and elevated shoe. In this group, the femoral head when first seen was 61 per cent. of normal height; it flattened to 49 per cent. under treatment, and improved to 55.5 per cent. The final results were much better than those treated with a cast only, — excellent, in 15.5 per cent., good, in 23 per cent.; fair, in 38.5 per cent.; and poor, in 23 per cent. The degenerative and regenerative phases averaged sixteen and one-half months each.

8. *Elevation of the Opposite Shoe and Crutches*

Fifteen patients were treated by placing an elevation of approximately two inches under the shoe on the well leg. The patient then walked with crutches with the involved leg hanging free, and without weight-bearing. This is the most recent group treated, and although the follow-up is limited as to time, it appears to be a very satisfactory method. The average case was seen with the femoral head 64 per cent. of normal height. During the course of treatment, flattening progressed to 50 per

cent., and improved to 60 per cent. The clinical results were excellent in 13.3 per cent. of the patients; good, in 53.4 per cent.; fair, in 20 per cent.; and poor, in 13.3 per cent. Since quite a number of these results were based on femoral heads still in the regenerative phase, it is probable that the final result will be even better than here represented. The degenerative and regenerative phases were approximately sixteen months each.

DISCUSSION

Of the 102 cases studied, ninety-three (91 per cent.) were males, and nine (9 per cent.) were females. Eleven cases (10 per cent.) were bilateral. The age when the patients were first seen varied from three to thirteen years, averaging eight and six-tenths years. Most of the patients were seen fairly early after the onset of the disease, and some were followed for six to eight years, giving a fairly accurate follow-up survey.

The average properly treated case of Legg-Perthes disease was found to run a course of approximately two and one-half years. If the treatment is improper, or lacking entirely, the course may be prolonged to as much as four years. In this disease, there are two phases—the degenerative and the regenerative. In the average well-treated case, the phases are approximately the same length, and each lasts about sixteen months. As Gill has noted, the change from one phase to the other is fairly abrupt. The results obtained depend on:

1. How early in the course of the disease the treatment is started;
2. The type of treatment used.

Usually, when a case is seen early and is given proper treatment, the head does not go on to such extensive flattening and fragmentation, and a better result is obtained in a shorter time. On the other hand, the case that is seen late and is improperly treated, or not treated at all, frequently has a prolonged course, and terminates with a flat, broad, irregular, distorted head.

In the opinion of Legg [8] and other early writers, the end results in cases of epiphysitis which received no treatment, were as good as those in the cases which were treated. This opinion is not shared by most of the present-day writers [4], and certainly does not correspond to the results seen in this study. The poorest results obtained were in the group which received no treatment.

Ideally, the treatment of Legg-Perthes disease should be started very early, when the changes are evidenced as only an increased density in the femoral head. Danforth, Eyre-Brook, Gill, and others prefer to treat such a case by placing the patient in bed with or without traction on the involved extremity until healing is complete. This is probably the best method of therapy from the standpoint of results in the hip. It is difficult, however, to get the full cooperation of either the patient or his parents for such prolonged recumbent treatment. This is particularly true in a condition which is so devoid of pain and other tangible symptoms. It is difficult to care for a patient in traction at home, and hospitalization

for such a prolonged period is often financially prohibitive. Therefore, whereas treatment in recumbency may be the best type to follow when it is feasible, it certainly cannot be applied to a large percentage of cases.

In searching for a substitute method of treatment which would give satisfactory results, the various methods previously mentioned were tried. From studying the results it becomes readily apparent that, if some form of non-weight-bearing treatment is started, it should be continued until the regenerative phase is completed. Very poor results were obtained in the group treated with immobilization followed by weight-bearing without additional support. Similarly poor results were seen from other methods when the patient would not cooperate in using non-weight-bearing appliances. In such cases it is quite reasonable to assume that the preliminary period of non-weight-bearing serves to decalcify the involved structures sufficiently to *encourage* flattening when weight-bearing is resumed too soon. Even in the regenerative phase of the disease, if the appliances are discontinued too soon, further flattening will occur.

The efficacy of multiple drilling as an adjunct to treatment is still a controversial subject. It does not seem to shorten the course of the disease, but it does seem to favor restoration of the femoral head in cases with considerable destruction. As seen in Table I, patients treated with multiple drilling had the greatest restoration of head height (14 per cent.). In this series, drilling was primarily used on those patients who had marked flattening and fragmentation of the femoral head when they were first seen; however, two patients were treated by drilling fairly early in the course of the disease, and both of these obtained good results.

TREATMENT OF CHOICE

The simplest and most effective method of treatment used was elevating the shoe on the well leg, and having the patient walk with crutches without weight-bearing on the involved leg. This type of treatment is readily available, inexpensive, and with reasonable cooperation will give good results. Since it is an ambulatory method of treatment, it is more readily accepted than recumbent or more encumbering types. The patient must be impressed, however, with the importance of walking on the crutches and well leg, and he must not walk or kneel on the involved leg. If the patient has only a moderately restricted range of motion without muscle spasm, this treatment is started immediately. If there is an adduction contracture or considerable muscle spasm, the patient is treated with preliminary traction for several weeks, until muscle relaxation and abduction are obtained. The hip is then immobilized in an abduction spica for three to four months, after which the patient is allowed up on crutches with an elevation under the well leg and no weight-bearing on the involved hip. Relatively few of the patients have sufficient hip deformity to warrant the preliminary traction and cast treatment.

It is felt that in cases of Legg-Perthes disease treated as outlined

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

Illustrations represent the course of a typical case of Legg-Perthes disease under treatment.

Fig. 1: August 1938. There is increased density in the epiphysis, but no flattening has occurred as yet. Treatment was started at this stage.

Fig. 2: March 1939.

Fig. 3: January 1940. Flattening had progressed to 50 per cent.

Fig. 4: September 1940.

Fig. 5: March 1941. The head had improved to 70 per cent. of the normal height.

the roentgenographic and clinical results compare favorably with those obtained by treatment with prolonged bed rest and traction (Figs. 1–5).

If the patient has bilateral hip involvement with the disease in an active state in both hips, the only effective method of treatment is complete bed rest. In most cases with bilateral involvement, however, one hip is involved some time before the other is affected, and the first hip may even be completely healed before the second one is involved. If both hips are not simultaneously involved, the elevated shoe and crutch treatment may be used satisfactorily.

A disabling feature which occasionally appears in the regenerative phase of this condition is a prominence of the lateral portion of the femoral head projecting beyond the superior acetabular rim. This prominence is the result of weight-bearing on the softened head, and is found usually in those patients who were seen for the first time relatively late in the course of the disease. It results in a mechanical block to abduction and frequently in a distortion of the acetabulum itself. When such cases are seen before the head is too well organized, they are treated with traction to obtain abduction, thereby placing the lateral prominence back under the acetabular roof. After this, the patients are immobilized in an abduction spica cast, extending only to the knee on the involved side. A two-bar caliper brace with a free knee joint is incorporated into the thigh portion of the cast, so as to allow knee motion while still protecting the leg from falls or missteps. In this apparatus, the patient is allowed up with full weight-bearing, thus allowing the acetabulum to remold the femoral head.

If a patient with a lateral prominence of the femoral head is first seen after the head has completely regenerated, a reconstruction operation is necessary.

REFERENCES

1. Bozsan, E. J.: A New Treatment of Intracapsular Fractures of the Neck of the Femur and Calvé-Legg-Perthes Disease. J. Bone and Joint Surg., XIV, 884, Oct. 1932.
2. Bozsan, E. J.: A New Treatment of Intracapsular Fractures of the Neck of the Femur and Legg-Calvé-Perthes Disease. Technique. J. Bone and Joint Surg., XVI, 75, Jan. 1934.
3. Danforth, M. S.: The Treatment of Legg-Calvé-Perthes Disease without Weight-Bearing. J. Bone and Joint Surg., XVI, 516, July 1934.
4. Eyre-Brook, A. L.: Osteochondritis Deformans Coxæ Juvenilis or Perthes Disease: The Results of Treatment by Traction in Recumbency. British J. Surg., XXIV, 166, July 1936.
5. Ferguson, A. B., and Howorth, M. B.: Coxa Plana and Related Conditions at the Hip. J. Bone and Joint Surg., XVI, 781, Oct. 1934.
6. Gill, A. B.: Legg-Perthes Disease of the Hip: Its Early Roentgenographic Manifestations and Its Cyclical Course. J. Bone and Joint Surg., XXII, 1013, Oct. 1940.
7. Legg, A. T.: An Obscure Affection of the Hip Joint. Boston Med. and Surg. J., CLXII, 202, 1910.
8. Legg, A. T.: Osteochondral Trophopathy of the Hip Joint. Surg. Gynec. Obstet., XXII, 307, 1916.

THE ADHERENT CAST IN THE TREATMENT OF CLUB-FOOT *

BY MALCOLM B. COUTTS, M.D., D.Sc., NEW YORK, N. Y.

From the New York Orthopaedic Dispensary and Hospital, New York

The wedging-plaster method for treatment of club feet published by Kite in 1930 had been in use at the New York Orthopaedic Dispensary and Hospital since a special Club-Foot Clinic was established there in 1928. Previously club feet were treated at this Hospital by frequent changes of plaster with manipulations which, after the first birthday, were performed under anaesthesia. The segregation of the patients with club feet into a special clinic, and the adoption of the wedging-plaster treatment improved results and reduced the number of surgical interventions.

The introduction of the adherent cast, wedged along lines based on the axial nature of the tarsal joints [1, 3], improved the statistics still further, and greatly reduced the time necessary for correction.

METHOD

Adhesion is obtained by the use of elastic adhesive as a lining to the plaster. The elastic adhesive sticks to the skin, and the plaster bandage sticks to the meshes in the outer surface of the elastic adhesive. Fungus infections and other skin irritations, prone to occur when any adhesive is left long in contact with skin, can be prevented by painting the skin of the foot and leg with tincture of benzoin prior to application of the adhesive. Even when infantile eczema is present, use of a coal-tar preparation will prevent irritation. The elastic adhesive is applied as a series of circular strips, and not as a continuous bandage. A gap is left between the strips at the level of the proposed wedging cuts to avoid wrinkling with the correction. A thin felt strip is affixed by a piece of elastic adhesive to the area where the proximal edge of the wedging cut will impinge. Further padding lessens the adhesive quality of the cast, but this much padding has proved necessary. Small folded reverses around the top and bottom of the cast and behind the heel insure uniform thickness and edge strength. The cast should be two to four millimeters thick to facilitate accurate molding, and to save time and trouble in making the wedging cuts. The plaster should be molded continuously while setting to secure firm adherence to the meshes in the adhesive. The contours of the leg and ankle should show plainly on the finished cast.

The wedging cuts should be made a week after the application of the plaster. After the correction is made, a layer of crepe-paper bandage is applied under the outer retention cuff of plaster bandage to facilitate re-

* Read before the Section on Orthopaedic Surgery of the New York Academy of Medicine, May 16, 1941.

FIG. 1-A

FIG. 1-B

1: For correcting adduction, whether through Chopart's joint, or a metatarsus varus, hinges are placed at the center of the instep and at the anterior end of the plantar surface of the heel.

2: For correcting the heel varus, hinges are placed at the center of the instep and just above the center of the tuberosity of the calcaneum.

3: For correcting equinus, hinges are placed just distal to the tips of the malleoli.

4: When the maximum correction has been obtained, a retention cast is applied.

moval of the cuff for further correction the following week. Being adherent, the cast cannot be kicked off nor will it rotate on the leg. Keeping the plaster below the knee obviates soiling of the cast, with consequent skin irritation, and permits knee motion.

Older children can be fitted with rubber-tipped walking irons, even where both feet are being treated. Walking is allowed as soon as the plaster is hard. The easier transportation facilitated by this iron, enlists a heartier cooperation on the part of the parents, often saves hospital admission, and permits the children their regular activities.

The wedging cuts employed leave narrow hinges of plaster at points corresponding to the projection of the axis of the joint which is being corrected.[1] These hinges have proved invaluable in guiding the corrective force along physiological lines.

The plasters shown in (Figs. 1-A and 1-B) illustrate the three types of wedging plaster used and a retention cast. All four types are employed consecutively, and the retention plaster is left in place at least eight weeks. Because of the rapid growth of young infants, their retention plasters should be changed every three weeks. The feet are never left out of plaster until the conclusion of treatment. The skin remains healthy if it is painted with tincture of benzoin at each plaster change. Much ground can be lost in short intervals out of plaster. When this method is carefully followed, pressure sores will be avoided even with the most stubborn foot or on the foot with deficient innervation. In this series, no pressure sore was encountered of sufficient magnitude to interfere with the continuous application of the plaster correction.

After the removal of the casts, the mother is instructed to manipulate the foot into dorsiflexion and eversion with every diaper change. If the child is walking, he should be provided with a straight-last shoe, wedged on the outer heel and sole three-sixteenths of an inch (five millimeters). Swung-in and swung-out shoes are better avoided.

RESULTS

In the years 1937 to 1939, treatment was commenced on new patients with forty-three club feet. These patients have been followed from one to three years since their last treatment. Thirty-eight feet were good in June 1941, and five feet stood in need of further treatment. Lengthen-

FIG. 2-A

Case 1. J. V. May 9, 1938. Condition of the feet at four weeks of age.

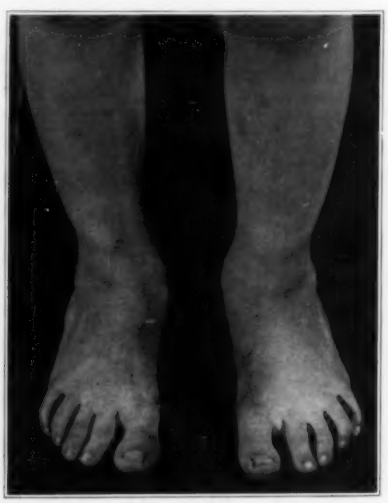

FIG. 2-B

April 20, 1942. Child is now four years old. Correction has been maintained.

ing of the Achilles tendon and capsulotomy had been performed on only two feet,—though some operative procedure may yet be necessary on some of the relapsed feet. In this group, there were twenty-six feet in infants admitted to the clinic under one year of age. Of these, only five feet required any further treatment after their first course of plaster, and, in 1941, the result was good in all feet. The average time for a complete course of treatment is five months.

Applied to children with a long record of relapses, the results are not so striking. A series of old patients with 49 relapsed feet, who had been treated during the previous decade in the Clinic, were treated during this same period (1937 to 1939). An overcorrection was obtained in all cases. In 1941, twenty-three of these were still satisfactory without further treatment, and twenty-six feet had required further wedging or operative treatment. Six of these feet were unsatisfactory because of a pigeon toe due to tibial torsion, and not to any residual deformity in the foot.

The method is applicable also as a preliminary procedure to syndesmectomy, tendon transplantations, and arthrodesing operations. It is valuable after soft-tissue

FIG. 3-A

Case 4. F. C. (Hospital No. 206026), September 15, 1937, aged six.

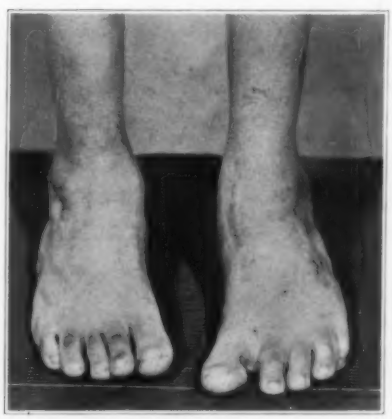

FIG. 3-B

FIG. 3-C

Case 4. F. C. (Hospital No. 206026), November 15, 1938, after treatment by wedging plasters over a period of eight months. This patient's right foot has shown a subsequent partial relapse and has required a triple arthrodesis. This difficult case illustrates that old or relapsed and scarred feet can be corrected by this method.

operations to complete correction, after the main obstacles have been removed surgically.

ILLUSTRATIVE CASES

CASE 1. J. V. (Hospital No. 216075), came to the Clinic in May 1938, when four weeks of age, with a left equinovarus of severe grade. Wedging plasters were applied. Since this foot yielded readily, only two wedgings were necessary in each of the three planes, and overcorrection in all planes was achieved in nine weeks. A retention plaster was applied for eight weeks. With removal of the retention cast, the mother was instructed in manipulation. At the age of one year, when he started to walk, he was fitted with straight-last shoes with lateral heels and sole wedges on the left. At the age of two, he was allowed to wear unwedged shoes, since his foot was apparently normal. On May 16, 1941, his left foot was slightly shorter than the right, and the left calf was slightly less stout than its normal fellow. The foot could be dorsiflexed to 75 degrees, had good voluntary evertor action, and the gait was normal. The follow-up was two years and eight months.

CASE 2. B. C. (Hospital No. 216245), came to the Clinic June 1938, at the age of one month, with a bilateral equinovarus partially correctable on manipulation. Wedging plasters were applied. The foot proved slightly resistant, and the wedging in the first plane had to be repeated. Overcorrection was obtained in all three planes at the end of thirteen weeks. After eight weeks further in retention casts, the plaster was removed, and the mother was instructed in manipulation of the feet. When the patient started to walk, he was fitted with straight-last wedged shoes. When these were worn out, he was given normal unwedged shoes which he has worn since. When seen on May 16, 1941, his gait was normal, and examination of the feet revealed no stigmata of his original deformity, except for the dimple over the outer aspect of the talar heads.

CASE 3. E. C. (Hospital No. 180352), was born in 1931, and from birth until the age of thirteen months was treated elsewhere, with corrective plaster casts, for right equinovarus. After a relapse in his second year, he was given a further course of treatment in plasters, lasting three months. This was followed by a tenotomy. The patient always walked pigeon-toed on his right foot, and wore off his shoes on the outside. At the age of four he came to the New York Orthopaedic Dispensary and Hospital Club-Foot Clinic. Examination showed a slight fixed varus of the heel, slight adduction through Chopart's joint, and 10 degrees of equinus deformity. Wedging plasters were applied, and, when overcorrection was completed in all planes, the patient was placed in a retention plaster for eight weeks. He was in plaster a total of twenty weeks. He was then fitted with straight-last wedged shoes which he wore for two years before discarding them for normal shoes at the age of seven. When last seen at the age of ten, the right foot was normal, except that it was slightly shorter than its fellow, and the right calf measured one inch less in circumference.

REFERENCES

1. DÖNITZ, ALFRED: Die Mechanik der Fusswurzel. Inaugural Dissertation. Berlin, Gustav Schade (Otto Fanke) 1903.
2. KITE, J. H.: Non-Operative Treatment of Congenital Clubfect: A Review of One Hundred Cases. Southern Med. J., XXIII, 337, 1930.
3. POIRIER ET CHARPY: Traité d'anatomie humaine. Ed. 2. Paris, 1: 325. Masson et Cie, 1399.

PERSISTENT OLECRANON EPIPHYSES IN ADULTS

BY D. H. O'DONOGHUE, M.D., AND L. STANLEY SELL, M.D., OKLAHOMA CITY, OKLAHOMA

A very careful search of the American and English literature has failed to reveal any reports of a case similar to one encountered in the authors' practice a few months ago, and this is believed to be sufficient justification for publishing a short résumé of the case history, and a very brief review of foreign literature on the same subject. The following report is submitted, therefore, first, to record in American literature what appears to be a rare anomaly at the elbow joint; and, second, to call attention again to the medicolegal significance of persistent epiphyses in areas exposed to trauma.

In childhood, the olecranon is entirely cartilaginous, and the bony olecranon process is formed by growth cephalad from the shaft of the ulna. The olecranon epiphyseal center usually appears in the cartilaginous cap at the age of nine or ten, and ossifies from the tip downward, normally uniting with the shaft at the age of fourteen. From available reports, it appears that epiphyseal separations at the olecranon are rare injuries. Eliason, in reporting 138 fractures in this immediate region, found only three epiphyseal separations, and these were in children under fourteen years of age.

Standard texts of roentgenology offer very little data on persistent olecranon epiphyses, and in the American literature no reference to this subject was found. However, there appears to be a considerable degree of confusion between a true unfused olecranon epiphyseal plate, and the so-called patella cubiti. There are several references in both the German and American literature to patella cubiti, which must not be confused with the entity here reported. It appears that Kienböck, in 1903, was the first to describe patella cubiti as an anomaly of the elbow joint. However, Köhler makes the clearest differentiation between the two, with a very definite description of both processes: first, true patella cubiti, embryonic in origin, a completely isolated piece of bone, articulating and mobile, and truly an accessory bone; second, simple persisting epiphysis, that is, a persistent epiphyseal plate, most commonly found on both sides, and having a tendency to occur in families.

The case reported falls definitely in the second group. In this particular instance, trauma called attention to the open epiphyseal plate on one side. Further roentgenograms revealed not only a persistent epiphyseal plate in the olecranon on the uninvolved arm, but also bilateral tripartite patellae. Roentgenographic study of other significant bones throughout the skeleton failed to reveal any further anomalies.

O. J. P., a white male, thirty-one years old, was first seen on October 14, 1941, following an injury to the right elbow. While loading pipe in an oil field, the patient was

FIG. 1

Original roentgenogram of the right elbow taken before surgery. Note the smooth wavy fracture line which led to the preoperative diagnosis of fracture through an unclosed epiphyseal plate.

FIG. 2

Roentgenogram of injured elbow five months after the open reduction and internal fixation with a vitallium screw. Note that the epiphyseal plate does not differ significantly from the opposite (uninjured) side in spite of the trauma incident to the fracture and open reduction.

struck across the right elbow by a loose piece of pipe. He had immediate pain and disability, and was taken to a local doctor, who applied a splint and sent the patient in for further treatment. Roentgenographic examination revealed a complete fracture through the olecranon process, apparently at the site of the old epiphyseal plate which was still open. This opinion was confirmed at operation, at which time the fracture site was seen to be definitely cartilaginous, and no raw bleeding bone was encountered, as is ordinarily seen in a fresh fracture. Anatomical reposition was obtained, and the fragment was held by one vitallium screw. The wound healed *per primam*, and two months after the operation, the patient was back at work, with no pain and only a few degrees of limitation of motion. Three months following the operation, the patient had a range of motion from 50 to 170 degrees, as compared with 50 to 175 degrees in the uninvolved elbow.

In spite of the trauma to this epiphyseal plate resulting from both the fracture and the open reduction, it still remains open at the last roent-

FIG. 3

Roentgenogram of the left (uninjured) elbow showing an open olecranon epiphysis. The patient had never had any symptoms in regard to this elbow, and had a full range of motion with normal strength and function.

genographic examination, five months after operation, and does not differ significantly from the uninjured plate on the opposite side. It was not possible to examine either the patient's father or brother in order to confirm Köhler's statement that this condition tends to occur in families.

In conclusion, the nature of this condition was suspected from the preoperative roentgenograms, and actually confirmed at the operation, at which time there was no fresh fracture site, but definite cartilaginous material. No effort was made at operation to close the epiphysis, other than by fixation with a vitallium screw. It is possible that this condition

is much more common than would be indicated from a search through the literature, and it would be interesting to hear from other physicians who have encountered a similar condition.

REFERENCES

COHN, ISIDORE: Normal Bones and Joints. Annals of Roentgenology, IV, New York, Paul B. Hoeber, 1924.

ELIASON, E. L. (In collaboration with Ralph Goldsmith and E. P. Pendergrass): Fractures of Humerus, Radius and Ulna. New York, D. Appleton and Co., 1925.

KIENBÖCK, R., UND DESENFANS, G.: Über Anomalien am Ellbogengelenk. Patella cubiti. Beitr. z. Klin. Chir., CLXV, 524, 1937.

KÖHLER, ALBAN: Röntgenology: The Borderlands of the Normal and Early Pathological in the Skiagram. New York, Willam Wood & Co., 1928.

THEISING, GERHARD: Zur Kenntnis der Patella cubiti (Ellenbogenscheibe). Röntgen-Praxis, XI, 663, 1939.

THE DIAGNOSIS AND TREATMENT OF KYPHOSIS DORSALIS JUVENILIS (SCHEUERMANN'S KYPHOSIS) IN THE EARLY STAGE

BY DR. ROBERT S. SIMON, JERUSALEM, PALESTINE

From the Department for Corrective Gymnastics of the Straus Health Centre, Hadassah Medical Organization, Jerusalem

During the last few years, in the Department for Corrective Gymnastics of the Straus Health Centre, Jerusalem, hundreds of children have been treated partly by corrective posture exercises and partly by intensive orthopaedic gymnastics. They were referred to the Department by the school doctors, because of bad posture, and were usually between the ages of eight and ten years. Examination showed a slightly rounded back, sometimes with a mild scoliosis, but with no fixation of the deformity.

These children may be divided into three groups. Group I represents the majority of children, and comprises those patients who, following a course of one year, were dismissed either improved or healed. Group II is composed of a small number of patients, whose condition remained unchanged, due in part either to irregular attendance or to lack of cooperation; this group also includes children with rachitic deformities. Group III, about 1 per cent. of the cases, is composed of those children whose condition became worse in spite of, or possibly on account of, the intensive gymnastics. It is with the third group that this paper is primarily concerned.

In the patients who showed impairment of the condition after a year's treatment, stiffness in the lower thoracic spine was noted. Following a course of more intensive gymnastics, which ordinarily would yield satisfactory results, the back became more bowed and the spine more extensively ankylosed. Roentgenographic examination showed the well-known signs of kyphosis dorsalis juvenilis,—flattening of the intervertebral discs, Schmorl's cartilaginous nodules, wedge-shaped vertebral bodies, and destruction of the epiphyses.

According to Scheuermann, the primary cause of the disease is disturbance of the epiphysis; while it was Schmorl's contention that the etiological factor is prolapse of the nucleus pulposus into the spongiosa through the weakened cartilage, especially where there are embryonal rests of the chorda dorsalis. In this way the disc becomes flattened and its turgor is disturbed, leading to a lesion of the epiphysis. All of these facts are demonstrated roentgenographically only after the disease has become quiescent; the prolapse of the nucleus pulposus is shown by the reactive osteoid tissue, which prevents further penetration, and the lack of turgor is explained by the shallowness of the intervertebral spaces.

Most authors have observed the disease in patients between the ages of fifteen and twenty-two years; Scheuermann's youngest patient was

thirteen years old. In some of the patients observed by the author, however, the disease began much earlier. Since healing and the prevention of pronounced and fixed kyphosis are possible only in the primary stage of the disease, an early diagnosis is of the utmost importance.

Following the theory of Schneider that there is some relationship between diseases of the epiphysis and vitamin-A deficiency, the eyes of all the children were examined for hemeralopia and xerophthalmia. It was found that most of the children with kyphosis dorsalis juvenilis suffered from slight hemeralopia, and xerophthalmia was found in two of the group from nine to thirteen years of age. In a parallel group of children with poor posture only, practically no hemeralopia was found, and no child with xerophthalmia.

The blood serum of these children was examined for carotene beta and vitamin A, and it was found that most of the children with kyphosis dorsalis juvenilis showed a lack or deficiency of vitamin A. In the blood-serum test for vitamin A, the average for the younger group with kyphosis dorsalis juvenilis was five international units, and for the older group, 130; the average for the total group with poor posture only was

FIG. 1-A

August 22, 1939. Roentgenogram of spine at age of eleven years, showing flattened intervertebral discs, wedge-shaped vertebral bodies, cartilaginous nodules, and destruction of epiphyses.

FIG. 1-B

May 2, 1940. Roentgenogram of same spine nine months later, following treatment. The kyphosis is less pronounced, and the destroyed portion of the epiphysis has been partly rebuilt by osteoid tissue.

eighty-five international units (without essential difference between the younger and older children). In the test for carotene beta, the average for the younger group of those with kyphosis dorsalis juvenilis was found to be 0.039 milligrams per 100 cubic centimeters of blood serum, and for the older group, 0.046; the average for the total group of those with poor posture only was 0.033.

Since roentgenographic examination of such young patients never shows the pronounced symptoms of the disease, the proof of vitamin-A deficiency is an important aid for early diagnosis. Moreover, if vitamin-A deficiency exists in older patients, it demonstrates that the active period of the disease has not passed.

Treatment of kyphosis dorsalis juvenilis in the early stage is based primarily on rest for the diseased spine. This is achieved by a plaster-of-Paris corset, which is worn for six months; wearing this corset, it is possible for the child to attend school. In addition, the child is given 40,000 international units of vitamin A daily for three months.

CONCLUSIONS

1. Kyphosis dorsalis juvenilis (Scheuermann's kyphosis) may be seen between the ages of fifteen and twenty-two years, but it may begin as early as eight or ten.

2. Proof of vitamin-A deficiency is an important supplementary aid in the early diagnosis of the disease.

3. Vitamin-A deficiency in older patients is a probable sign that the disease is still active.

4. Children in the early stage of the disease should be excluded from physical exercises, should be given vitamin A, and should wear plaster-of-Paris corsets.

REFERENCES

SCHEUERMANN, H.: Kyphosis Dorsalis Juvenilis. Ztschr. f. Orthop. Chir., XLI, 305, 1921.

SCHNEIDER, ERICH: Die Vitamine in der Chirurgie. (Vorträge aus d. praktischen Chirurgie, H. 17.) S. 53. Stuttgart, Ferdinand Enke, 1937.

NEURILEMMOMA OF BONE

A Case Report

BY A. H. CONLEY, M.D., AND D. S. MILLER, M.D., CHICAGO, ILLINOIS

Primary nerve-sheath tumor of bone is an extremely rare condition. Peers described an intramedullary neurogenic sarcoma of the ulna and discussed the histogenesis of this tumor rather thoroughly. An amputation was done in his case.

Gross, Bailey, and Jacox were the first to describe a type of bone tumor which was benign in spite of the fact that it was locally invasive. De Santo and Burgess in 1940 reported a case of a nerve-sheath tumor which they considered benign. Their treatment was resection of the involved portion of the ulna, whereas the case reported by Gross, Bailey, and Jacox was treated by local excision.

The question of malignancy in this type of tumor is very important,—the treatment depending upon the microscopic diagnosis of the tumor.

This nerve-sheath tumor has in the past been called by many names such as neurofibroma, schwannoma, perineurial fibroblastoma, and peripheral neuroma. The term "neurilemmoma", used by Stout, is quite appropriate, and is used to describe the tumor in the following case, which, since the authors have had the opportunity to observe the patient for three years following operation for the removal of the tumor, seems of unusual interest.

Mrs. E. H., aged thirty-two, married, and the mother of one child, entered the Orthopaedic Clinic of the Cook County Hospital on March 16, 1939, with a history of pain along the distribution of the left sciatic nerve, numbness, and coldness of the entire left extremity. There was marked visible atrophy of the calf and thigh. The history of the condition dated back to 1928, when, two months after the birth of her child, pain developed in the left sciatic nerve and became progressively worse. Continual sedation was necessary, and, after two years, some regression of the pain was noted. There were periods of severe pain alternating with periods of paraesthesia of the left foot. During this interim a limp developed which became quite apparent, and was steppage in quality. She was unable to stand well on her toes or heel. Her past history was normal except for an oophorectomy eleven years previously. The report of the biopsy specimen of the ovary is not known.

A neurological examination made on admission revealed the following: There was visible atrophy of the left calf muscles and of the thigh; all movements of both lower extremities were possible; the Lasègue test was negative on the right, but positive on the left; the fabere test was negative bilaterally; the knee jerks were present bilaterally; and the ankle jerk was absent on the left. The plantar reflex was diminished on the left side; there was hypo-aesthesia to pain, touch, and vibration in the area of the left calf; the pupils reacted to light and accommodation; the cranial nerves revealed no pathology; and the fundi were normal. The impression was that of a low-sacral root lesion, probably at the fifth lumbar and first sacral on the left side, or a cauda equina lesion. Roentgenograms on this date revealed a delineated bone lesion the size of half a dollar, in the first sacral vertebra, left of the mid-line, which appeared cystic in nature.

FIG. 1

Roentgenogram taken February 23, 1939, shows the large half-dollar sized area of rarefaction with a thin sclerotic wall at the upper margin of the first sacral vertebra, just to the left of the mid-line.

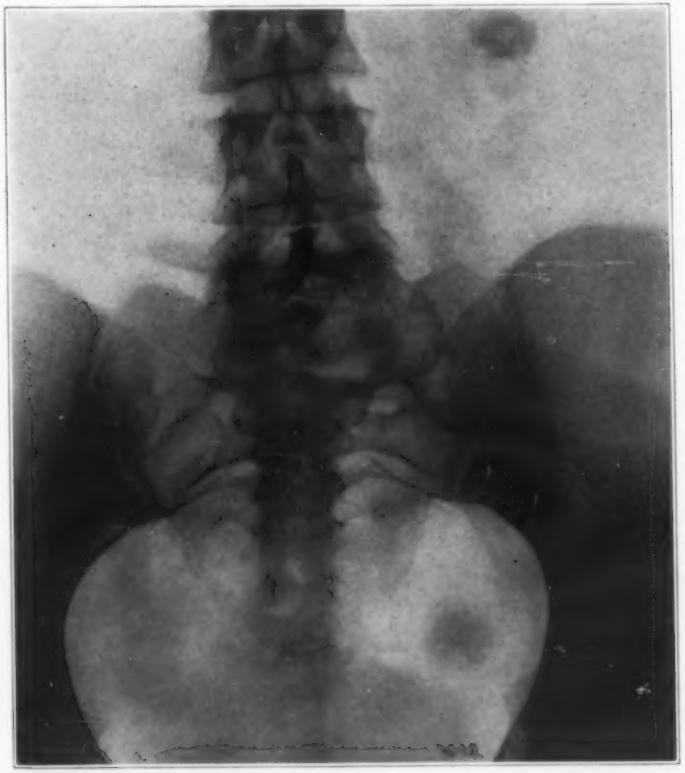

FIG. 2

August 31, 1939. Beginning sclerosis is evident. The rarefaction is not so prominent as in the previous roentgenogram, and the wall of the cyst is somewhat thicker.

A spinal puncture revealed a clear, colorless liquid; the manometric response was good; the spinal Wassermann was negative, the total protein being thirty-five milligrams per 100 cubic centimeters. Blood phosphorus was 3.33 per 100 cubic centimeters; calcium, 9.76; and phosphatase, 3.34. The blood Wassermann, urine, and total blood counts were normal.

At operation on March 23, 1939, the tumor was found to be encapsulated in the first sacral vertebra, lateral to the sacral canal which was definitely encroached upon. The first posterior sacral foramen was intact, and was not isolated during surgery. The tumor was reached through a linear incision two and one-half inches long directly over the first sacral vertebra. The skin, subcutaneous tissue, and the upper border of the multifidus were retracted, and the posterior wall of the tumor was seen as a thin cortical extension. This shell was removed by osteotome, and a thick grayish-yellow friable material was seen to extend through the entire cyst wall. The wall proper was fibrous in nature, and the medial extension of the cyst definitely encroached upon the sacral canal longitudinally for a distance of about two centimeters. There was no direct continuity between this and the sacral canal. The tumor was removed piecemeal by curettement, the wall was entirely curetted until raw bleeding bone was encountered; and the space left filled with blood, and no bone chips were replaced. The overlying soft structures were sutured, and the skin was closed without a drain.

FIG. 3

May 23, 1940. The cyst wall is indistinguishable from the remainder of the bone. The cystic area has been filled in almost completely, except for a small area towards the mid-line.

The patient made an uneventful recovery. She was kept on a Bradford frame for three weeks and then wore a rigid lumbar corset.

The pathological report submitted by A. Ragins, M.D., was as follows:

"There are present multiple nerve-sheath cells in the characteristic palisade formation. A loose, connective-tissue stroma is the basis."

Following surgery the patient received roentgenotherapy weekly for ten weeks. Follow-up roentgenograms indicated a filling-in process in which the location of the original tumor had been almost entirely replaced by bone.

On September 15, 1941, two and one-half years after surgery, a neurological examination revealed the following: Atrophy was still present in the left calf and thigh; the knee jerks were present bilaterally, the right one more brisk than the left; both ankle jerks were present; deep tendon sensations were present; the left foot still indicated a mild talipes equinovarus deformity; and steppage gait was still present.

Briefly, the patient indicated improvement in the return of some of the sensation; the left ankle jerk had returned; the weakness was less; and the vibration sense had also returned. There was less atrophy of the calf and thigh. The conclusion was reached that there was a residual lesion of the fifth lumbar and first sacral roots.

Three years following surgery she was doing well, having had no recurrence of her pain although the original atrophy still remained. This last examination, made on March

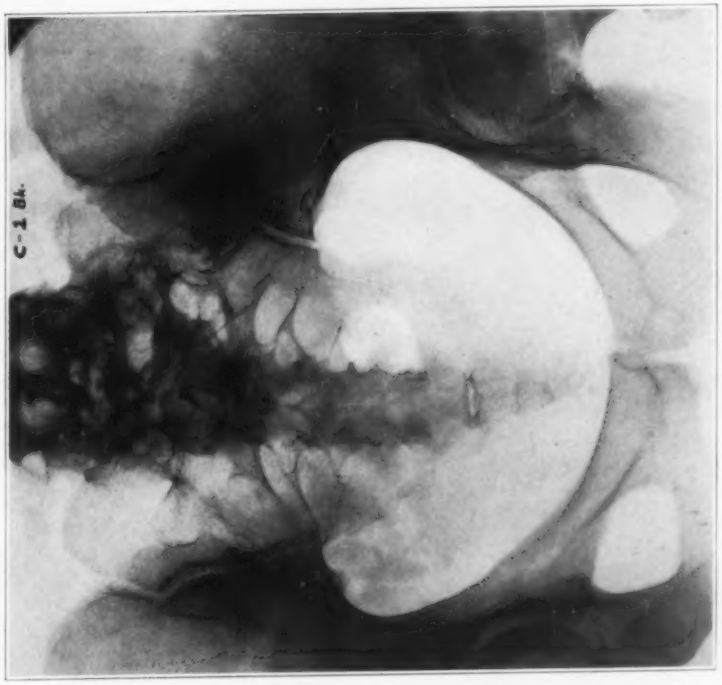

FIG. 5

September 15, 1941. The roentgenogram indicates a rather diffuse filling-in of the previous defect. The small rarefied area with a mild trabeculation is still present.

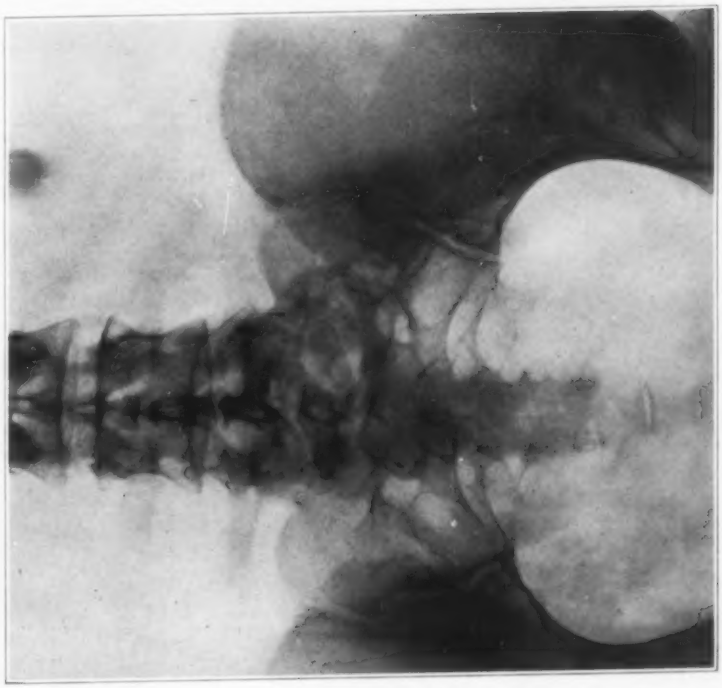

FIG. 4

August 15, 1940. Sclerosis is slightly more advanced than in the previous roentgenogram.

16, 1942, indicated that the patient had relief of pain, with the visible atrophy of the left calf and thigh less than that seen previously.

Figure 1 shows the tumor before surgery and Figures 2, 3, 4, and 5, the follow-up roentgenograms. Figure 6 demonstrates the characteristic appearance of this type of tumor, showing the palisading of nerve cells and the peculiar grouping.

FIG. 6

Photomicrograph (× 150) shows palisading of the nuclei which is characteristic of neurilemmoma of bone. No indication of malignancy is seen.

CONCLUSIONS

A three-year study of a case of neurilemmoma, a rather rare type of bone tumor, indicates the definite progress from both roentgenographic and clinical viewpoints, which has been made in this patient.

The neurological examination of the patient indicated, in all probability, that this was a lesion in the region of the cauda equina. This must be differentiated from lumbosacral lesions, sciatic nerve neuritis, multiple nerve-sheath lesions, and the possibility of a ruptured intervertebral disc. The roentgenographic appearance of the tumor in this vicinity, and its encroachment upon the sacral canal excluded, anatomically, lesions of the above group. The relief of pain, in all probability, indirectly helped the patient's gait and the reduction of pressure in the canal may have directly relieved symptoms.

That there was no intrinsic cauda equina tumor may be inferred from the negative spinal tap which gave no evidence of irritation.

The authors concur with De Santo and Burgess that this is a benign tumor, and that excision, followed by roentgenotherapy, is the treatment of choice.

REFERENCES

De Santo, D. A., and Burgess, Ernest: Primary and Secondary Neurilemmoma of Bone. Surg. Gynec. Obstet., LXXI, 454, 1940.

Gross, Paul; Bailey, F. R.; and Jacox, H. W.: Primary Intramedullary Neurofibroma of the Humerus. Arch. Pathol., XXVIII, 716, 1939.

Peers, J. H.: Primary Intramedullary Neurogenic Sarcoma of the Ulna. Report of a Case. Am. J. Pathol., X, 811, 1934.

Stout, A. P.: The Peripheral Manifestations of the Specific Nerve Sheath Tumor (Neurilemoma). Am. J. Cancer, XXIV, 751, 1935.

A METHOD OF TREATMENT USED IN FRACTURE OF THE ACETABULUM

BY R. F. DEWITT, M.D., PLYMOUTH, NEW HAMPSHIRE

The usual method of treatment of the comparatively rare fractures of the acetabulum includes adhesive traction, but there are times when skin traction is not feasible. The following case report illustrates a method of obtaining a diagonal pull without skin traction.

Mrs. L. P. H., white, aged sixty, five feet four and one-half inches tall, and weighing 175 pounds, fell from a step ladder on April 18, 1938, landing directly on the left trochanter, and forcing the head of the femur through the acetabular wall into the pelvis (Fig. 1).

The original treatment was by Buck's extension and a wide adhesive lateral pull. This soon led to serious damage to the skin. Therefore, a Kirschner wire was placed through the lower end of the femur and a fifteen-pound weight was attached, as in treatment for a fracture of the shaft of the femur. Then an eye screw of stainless steel was placed in the lower portion of the greater trochanter and a six-pound weight was slung over a pulley to the side of the bed at right angles to the pull through the Kirschner wire. The combination of these two pulls provided a diagonal pull in the direction of the femoral neck. This was followed by roentgenographic examination and the adjustment of weights as indicated.

The patient had considerable increase in freedom of motion and in general comfort; and the nursing care was made easier.

Traction was maintained for eleven weeks, and weight-bearing was begun four weeks

FIG. 1

April 18, 1938. Roentgenogram shows the acetabulum to be fractured in three places.

later. Crutches were used, beginning two weeks after traction was removed.

Three years after injury, the patient had a very slight limp, and bony union was complete. However, as Figure 3 shows, aseptic necrosis of the femoral head, which is common in these cases, and degenerative arthritis have developed. The patient at the present time is able to flex the hip to 90 degrees, has lateral motion of 20 degrees, but no motion posteriorly. She walks with only a slight limp. No cane or other support is used in an active daily routine. There is no complaint of pain in any form.

It is the author's hope that this method of treatment may be given trial by others, and an accurate evaluation made.

FIG. 2

June 9, 1938. Showing reduction obtained.

FIG. 3

February 24, 1941. Bony union is complete, but aseptic necrosis of the head of the femur and degenerative arthritis have developed.

AN APPLIANCE FOR THE EASIER AND MORE EFFICIENT APPLICATION OF SKELETAL TRACTION WITH THE STEINMANN PIN

BY JOHN LYFORD, III, M.D., AND H. ALVAN JONES, M.D.,
BALTIMORE, MARYLAND

From the Division of Orthopaedic Surgery, The Johns Hopkins Hospital, Baltimore

The application of skeletal traction with the Steinmann pin may be made easier and more satisfactory by employing a stirrup which is easily attached to the pin, is adjustable as to length and width, and is fitted with a readily removable foot-plate. The parts of such a stirrup are shown in Figures 1, 2, and 3. The stirrup forms a rectangle when attached to the Steinmann pin; hence a pulling force exerted on any point of the stirrup will be transmitted throughout all parts of the appliance directly to the Steinmann pin, and therefore to the bone. Thus permanently maintained rotary and angulating forces can be exerted on the bone, with only a single pulling force being necessary to bring about any given desired action on the bone.

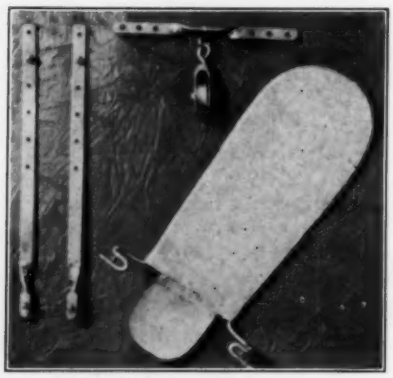

FIG. 1

The parts of the attachment, and the foot-plate.

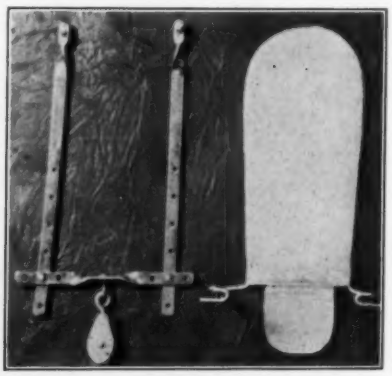

FIG. 2

The foot-plate and attachment assembled for use without the foot-plate.

FIG. 3

The attachment assembled for use with the foot-plate.

The foot-plate can be used readily when the Steinmann pin is placed through the os calcis or lower end of the tibia. In such instances it not only simplifies the problem of preventing foot-drop, but permits anterior

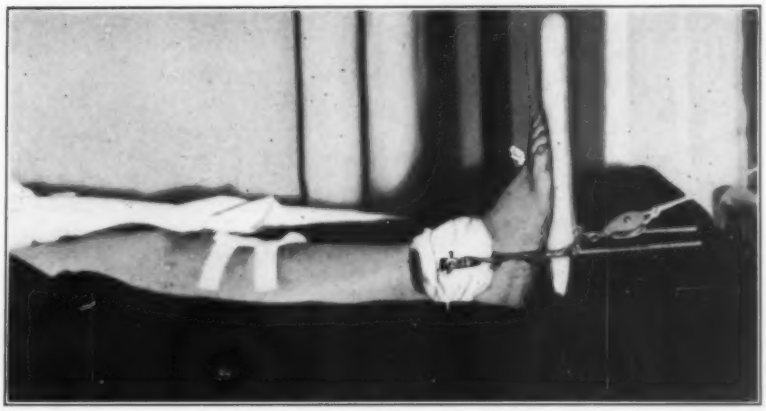

FIG. 4
The attachment in use with the Steinmann pin with simple extension traction.

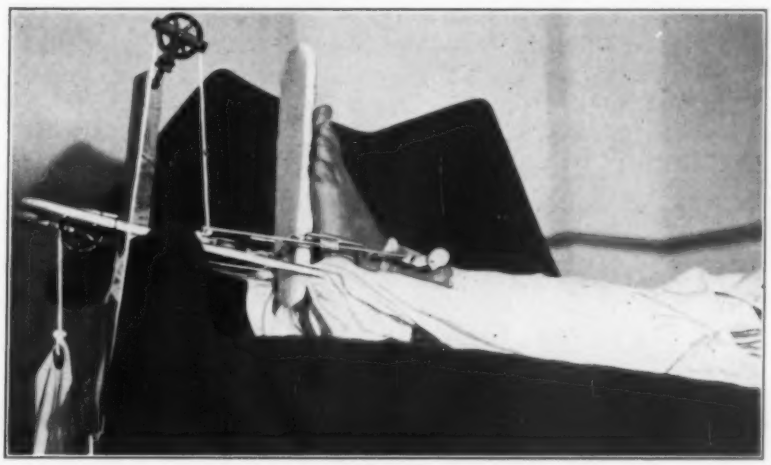

FIG. 5
An application of the attachment, showing the use of traction to obtain medial rotation of the distal fracture fragment.

and posterior angulating forces to be exerted on the bone (Figs. 4 and 5). These forces are transmitted to the bone through the fulcrum of the cross-bar which holds the foot-plate against the patient's foot, and prevents the plate slipping distally when the foot is plantar flexed (Figs. 3, 4, and 5).

Variations in the methods of applying traction to the stirrup, so as to obtain combinations of forces acting on the bone, are readily apparent. Figure 4 shows the appliance in use with simple extension traction. An application of traction to the stirrup to obtain medial or lateral rotation of the bone is shown in Figure 5.

The swivel pulley on the cross-bar facilitates the easy application of the Russell type of traction, without further modification of the stirrup, when this type of traction is used with a Steinmann pin passed through the os calcis or the distal end of the tibia.

A LIGHT FRACTURE FRAME: ITS USES AND CONSTRUCTION

BY E. W. CLEARY, M.D., BURLINGAME, CALIFORNIA

In 1935[1], the author described a frame which has since been used in the reduction of hundreds of fractures, and has proved helpful to a number of surgeons. Presentation of the improved frame seems worth while.

The frame is particularly adaptable for fractures of the tibia and fibula (Fig. 1), of the radius and ulna (Fig. 2), and of the os calcis. (Artificial limbs were used for illustration in the interest of clearer photography.) The appliance has been effective for reduction of fractures of the humerus and femur, for multiple fracture dislocations of the tarsals and metatarsals, and for reduction of shoulder dislocations of long standing. It has simplified the management of compound fractures. Surgeons treating fractures under conditions where adequate fracture equipment is not provided by an available hospital have found it especially helpful.

The disassembled frame (Fig. 3) can be put together in less than five minutes, and, when disassembled, may be packed into a small flat canvas bag. It weighs six and one-half pounds, the base weighing two and one-quarter pounds. If the occasion requires, it may be totally sterilized before assembly.

There is seldom occasion for retaining a frame for more than two hours to serve any one patient, but the equipment may be duplicated at

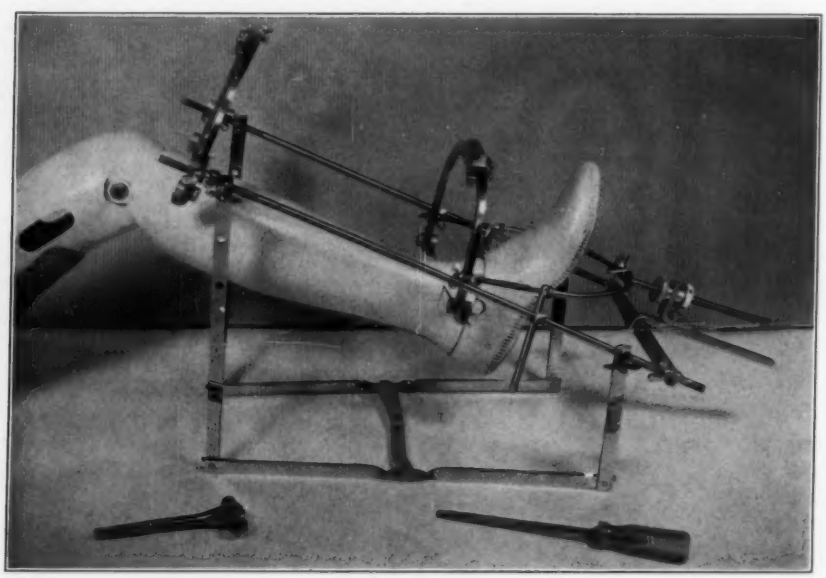

FIG. 1
Frame set up for traction on fractures of the leg bones.

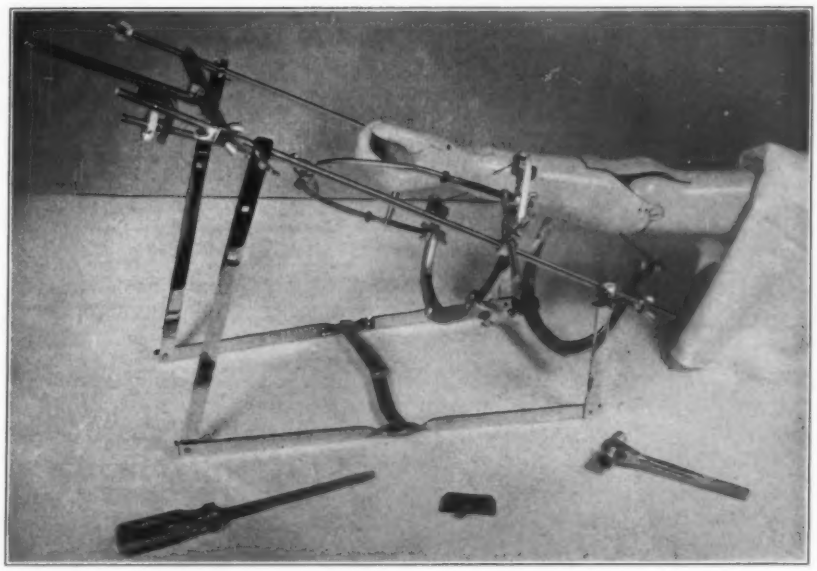

FIG. 2
Frame as used for forearm bone fractures.

such small cost and requires so little space for storage, that institutions which care for a large number of fractures, may provide a sufficient number of frames to meet any emergency. An assembly so light, adaptable, and easily fabricated may be especially useful during the national emergency.

For fractures of the tibia and fibula (Fig. 1), the frame base is raised proximally, so as to produce about 60 degrees of flexion in the knee. Note that in forearm fractures (Fig. 2), the base is reversed, so that the proximal bow of the frame is beneath the arm. When the frame has been put on a fractured limb and some traction has been applied, the limb and frame are lifted, the base (Fig. 3 *P*) is opened up, placed under the frame, and clamped to it.

The fractured limb is so accessible in this frame, that roentgenograms are readily taken, and casts or dressings are applied with relative facility.

After roentgenograms show reduction, a cast is applied, using standard quick-setting plaster. Clamps (Fig. 3 *T*) are tightened upon either end of each wire where it emerges from the cast. Wet plaster bandage is packed firmly between the clamp and cast, thus maintaining tension on the wire after it is released from the bow. Wires securely anchored in the cast *under tension* render correction by wedging the cast, if this is subsequently found to be necessary, safer and more effective. When the plaster has set (ten to fifteen minutes) the wires are cut outside the clamps and the frame is removed. If the frame is to remain on long without a cast, a sling support (not illustrated) is attached to the proximal bow and utilized to take the weight of the limb off the proximal wire.

In the reduction of old shoulder dislocations, the proximal wire is

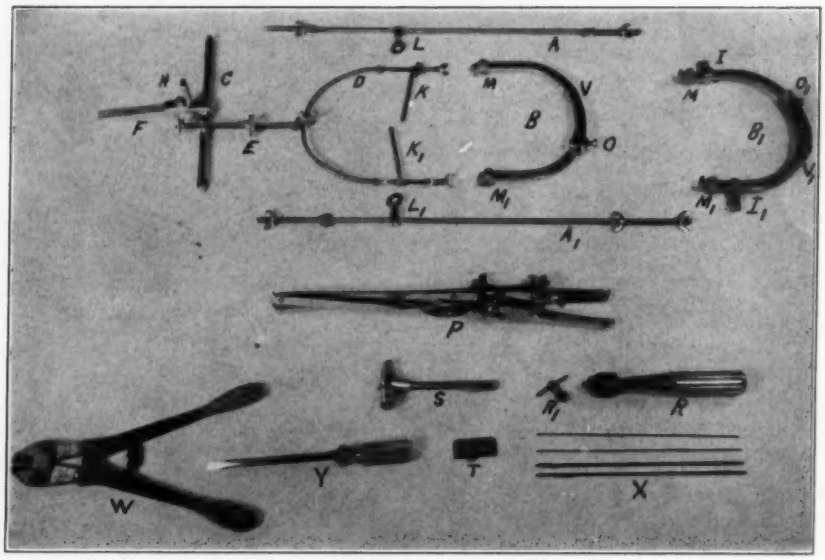

FIG. 3

A and A_1 frame rods; *B*, traction bow; and B_1, stationary bow comprise the proximal element of the frame. *C* is the foot piece of the frame; *D*, the bridle of the traction bow; *E*, traction screw; *F*, traction base bar; *H*, angle piece; *I* and I_1, projecting plates to receive *A* and A_1; *K* and K_1, supporting rods; *L* and L_1, supporting rod clamps; *M* and M_1, wire-locking discs; *O* and O_1, tension screws; *P*, collapsible frame base; *R*, wire-driving tool; R_1, chuck wrench; *S*, double-socket ratchet wrench; *T*, wire clamps; *V* and V_1, hinge screws; *W*, wire cutter; *X*, stainless-steel wires one-eighth of an inch and one-sixteenth of an inch in diameter; and *Y*, screw driver.

passed from front to back through the soft tissues beneath the acromion and the distal wire through the humerus above the condyles. In forearm fractures, the proximal wire traverses the ulna about an inch below the olecranon, the distal wire transfixes the radius only, about one inch above the wrist. This wire is inserted near the ventral margin and passes dorsally and ulnarward through the radius, emerging clear of the ulna on the dorsal surface.

A two-stage procedure is used on fractures in the upper third of the femoral shaft. First, two wires one-eighth of an inch thick and inserted at a considerable angle to each other, are driven from the lateral surface of the thigh well into, but not through, the upper femoral fragment. The proximal wire should pass through the trochanter and penetrate well into the femoral neck. The second wire is inserted in the same anteroposterior plane, about two inches distal to the first, and is driven toward the proximal wire, at an angle of approximately 60 degrees, when viewed anteroposteriorly. A plaster spica includes both clamped wires, and terminates distally at about the level of the fracture. Wires are cut off outside the clamps, and the clamps and wire ends are incorporated in the cast. A wire tensed in the upper bow (Fig. 3 B_1) of the frame is placed transversely across the anterior surface of the cast near its distal extremity. The middle of this wire is incorporated in the cast. This completes the first stage.

As soon as the plaster has set sufficiently, another wire is driven transversely through the femoral condyles and is locked in the traction bow (Fig. 3 *B*). The frame and base are then set up as for fractures of the lower leg, traction is applied, and reduction is verified. The cast is then extended to the foot, the distal wire is clamped, and the frame is removed.

If available, a good fracture table is preferable for high fractures of the femur in adults.

For all transfixion traction, stainless-steel wires (chrome 18, nickel 8, carbon .08) in two sizes (one-sixteenth and one-eighth of an inch in diameter) are used. These are purchased by the pound and are cut in straight ten-inch lengths. The wires are pointed with a fine mill file or on a grinder. The author prefers a three-faceted trocar point. Points with facets twice as long as they are broad, readily cut through bone. He prefers to puncture the skin directly with both large and small wires. Additional transfixion wires are used whenever more than two seem to be needed. The wire-driving instrument (Fig. 3 *R*) is used in preference to any drill. This instrument has a hollow handle of duraluminum or monel metal, fluted and tapered. It is fitted to a Jacobs chuck. The chuck is drilled through, so that the larger-sized wire passes entirely through the instrument which is eight inches long. The use of this instrument leaves one hand of the operator free to grasp and steady the injured limb. Fibrous tissue does not wrap around the wires, and ring sequestration from friction burn does not occur when such an instrument is used. Some patience is required to drill the adult femoral shaft.

Abundant threads on the bars (*A* and A_1), the bridle (*D*), and the long traction screw (*E*), provide sufficient longitudinal adjustment of the frame to meet the requirements for any ordinary fracture (See Figure 3). A further range of adjustment is added by the choice of several holes in the traction base bar (*F*) for attachment of the angle piece (*H*). Time is saved by adjusting the span of the frame to the problem in hand before putting it on the fractured limb. Where distance between the proximal and distal wires is short, as in fractures of the os calcis *F* and *H* may be dispensed with, and the traction screw (*E*) may be operated through the center of the foot piece (*C*). Appropriate one-sided adjustment of the wing nuts on the bars (*A* and A_1) or the bridle (*D*), takes care of any tendency toward lateral angulation of a fracture. Free swiveling of the bow (*B*) with the traction screw (*E*) gives a complete range of rotation adjustments. Locking the knurled nuts on the traction screw holds any position of rotation. Sagging is prevented, and position in rotation is rendered doubly secure by gripping the supporting rods (*K* and K_1) to the frame bars (*A* and A_1), with clamps (*L* and L_1).

CONSTRUCTION

The frame is constructed of readily available materials, and any good mechanic with a few simple tools can make it. All rods and cold-rolled-steel bars are bent cold, using vise and bending irons. The tool-steel

locking discs must be brought to a white heat and chilled to secure a glass-hard temper. A lathe is necessary to turn out knurled nuts, but wing nuts may be substituted on the traction screw. Frames look better and are more easily cleaned if plated.

The collapsible base (*P*) is made of steel strap and is put together with round-headed rivets, so that it folds easily. Three holes in each long leg provide for height adjustment. Clamp hooks—square in cross-section—in square holes, open upward to receive the frame. Wire is cut with bolt cutter (*W*), or with Schollhorn-type pliers (not illustrated). The ratchet wrench (*S*), used to tighten locking discs (*M* and M_1) and tension screws (*O* and O_1), is stocked by auto-supply houses. Slots in the heads of all tap screws and bolts permit adjustment with screw driver as well as wrench.

All threads on adjustable parts are made reasonably loose. All holes, except those for locking discs and hinge bolts, are reamed out to an easy fit. The use of standard sizes of bolts, screws, wing-nuts, steel bars, and rods throughout, not only reduces cost of construction, but facilitates replacement of any part.

1. Cleary, E. W.: A Light Inexpensive Frame for Transfixion-Wire Traction on Fracture of the Forearm and Leg. J. Bone and Joint Surg., XVII, 494, Apr. 1935.

A SURVEY OF END RESULTS ON STABILIZATION OF THE PARALYTIC SHOULDER*†

REPORT OF THE RESEARCH COMMITTEE OF THE AMERICAN ORTHOPAEDIC ASSOCIATION

This report is based on a study of patients in twenty representative clinics throughout the country, conducted by the traveling fellow under the direction of your Research Committee. The study included only cases of infantile paralysis with some form of surgical stabilization of the shoulder, which had been done at least one year prior to examination. One hundred and forty-eight patients were examined, of whom 101 presented shoulder fusion (one patient had a bilateral fusion); forty-three, some form of muscle transplantation; two, the Nicola operation for subluxation of the shoulder; and one, a fascial sling operation, done by tying the two scapulae together.

I. ARTHRODESIS

Early in the course of the investigation, certain facts became apparent. We have felt that, in all of the 102 shoulders on which an arthrodesis had been attempted, some benefit had been received through increased stability, regardless of the position and whether or not fusion had occurred. However, less than 10 per cent. of the cases met all the criteria necessary to be classed as excellent. The results in a large majority of arthrodesed shoulders were below the possible optimum, because of some relatively minor defect in their management, the most frequent of which was some error in postoperative position. It would seem that too little attention was paid by the surgeon to the relative position of the humerus and the scapula. The majority of us have been placing the humerus in relation to the trunk and neglecting its relationship to the scapula. Too much emphasis has been placed, also, on securing abduction, but not enough on the degree of rotation of the arm.

Plan of Study

In studying the arthrodesed shoulder, an attempt was made to determine the actual position of fusion at the shoulder joint, the active range of motion of the arm in relation to the trunk, and the power in the muscle groups controlling the shoulder girdle. After this data was obtained on each case, an attempt was made to visualize some manner in which this individual patient might have been benefited by a change in treatment. In this way we have hoped to develop more accurate clinical information regarding the management of these cases than would be possible by a statistical study of averages.

The position of the arthrodesis was determined by maintaining the scapula in its normal anatomical position, and then measuring the humerus in relation to the axis of the body. Abduction was measured by determining the angle between the humerus and the sagittal plane of the body, while flexion was measured by determining the angle between the humerus and the frontal plane. Rotation was determined by flexing the elbow to a right angle and then, with the arm at the side, measuring the angle between the forearm and the sagittal plane of the body.

The average position of fusion in this series was found to be 40 degrees of abduction, 10 degrees of flexion, and 42 degrees of internal rotation. The average active rotation of the scapula in these cases was 70 degrees, which represents the difference between the completely abducted arm and the arm resting against the side of the body. This position is not the optimum for all cases, and it is felt that in general the position recommended for fusion will vary somewhat according to the age, sex, and remaining muscle power. With fair to good power in both the trapezius and the serratus anterior, we believe the position

* Read at the Annual Meeting of The American Orthopaedic Association, Baltimore, Maryland, June 6, 1942.

† This study has been sponsored by The National Foundation for Infantile Paralysis, Inc., New York, N. Y.

of fusion should be 45 to 55 degrees of abduction, 15 to 25 degrees of flexion, and 15 to 25 degrees of internal rotation.

Analysis of Position

It has been our observation in this study that a greater range of motion of the scapula develops in younger individuals than in the older patients. We have found that with the shoulder fused at 45 degrees of abduction, and with good muscles controlling the scapula, the arm will come to the side without winging, and can be actively abducted to about 90 degrees. A little more abduction will improve the functional result, but will not give so good a cosmetic effect. For this reason, in boys under twelve, the shoulder can be fused in 55 degrees of abduction. This may result in the arm hanging out from the side and a slight winging of the scapula. Girls object strenuously to this degree of abduction, in spite of the better function resulting from such a position.

Proper function of the fused shoulder in abduction depends on good power in the upper trapezius and in the upper two-thirds of the serratus anterior. The upper trapezius acts as an abductor by elevating the acromion, the entire shoulder girdle pivoting at the sternoclavicular joint. This will occur in the absence of power in the serratus anterior and several such cases were observed in this study.

Several facts were demonstrated when an arthrodesis was done without an active serratus. First, the trapezius can only abduct the arm about 45 degrees without the aid of the serratus anterior. Second, when the humerus is fused at 45 degrees or more from the scapula, with an absent serratus anterior, the weight of the arm may rotate and depress the outer portion of the scapula to such a degree that the trapezius is overstretched and further weakened. It, therefore, appears that, in the absence of the serratus anterior, the angle of fusion in abduction should not be over 30 degrees in relation to the vertebral border of the scapula.

A few cases were noted with paralysis of all the muscles about the shoulder, except fair power in the trapezius, and yet, even in these, there was marked improvement following an arthrodesis. It has also been shown in this study that at least the appearance of the flail shoulder can be improved by a properly performed arthrodesis, because the flail shoulder, which is usually carried higher, is aligned normally following fusion.

The proper position for function is, of course, the important one. In none of the clinics visited did there seem to be a constant relationship between the position in which the surgeon thought he was fusing the shoulder and the final position, or the position noted in the immediate postoperative roentgenogram. In one of the cases, the surgeon had not been satisfied with the amount of abduction present in the immediate postoperative roentgenogram, and four days later the plaster was wedged into 25 degrees more of abduction at the shoulder, giving an apparent improvement. A new roentgenogram, however, showed that only 5 degrees more of actual abduction in the joint had been obtained. This discrepancy between the actual abduction which is obtained, and that which the surgeon believes he has obtained, or intended to secure, is probably due largely to adduction contracture between the humerus and the scapula. In the majority of cases, the arm has been hanging at the side for a number of years before operation, and contractures usually have developed. As the result of recent interest in the Kenny treatment, it is likely that these contractures may be prevented in the future.

There has been found in this study a widespread opinion that arthrodesis of the shoulder should not be done in girls, because of a poor cosmetic result. With this we do not agree.

Abduction: True abduction can be measured at the operation by determining the angle between the vertebral border of the scapula and the humerus. After these bones have been adjusted to the desired position, the arm and scapula can be rotated as a unit to a position of 70 to 90 degrees of abduction of the arm in relation to the trunk, permitting a relaxation of the upper trapezius and serratus anterior. There is usually sufficient contracture of the adductors, so that the scapula will follow the arm. This relationship may not remain accurate, because of changes which are prone to occur in the angle of

abduction, due to rotation of the scapula within the plaster. This angle may decrease because of the pull of the adductors, or it may increase as the contracting adductors are stretched. Both conditions have been found in this study. It is our opinion that some form of internal fixation should be used between the scapula and the humerus. This may be obtained by the use of metal or bone which is inserted through the head of the humerus into the glenoid, or by fixation of the acromion to the humeral head or greater tuberosity.

Flexion: The amount of flexion in the fused shoulder is important from the standpoint of both function and cosmetic effect. Securing the correct amount of flexion is difficult. An attempt has been made to determine what would be the optimum position of flexion desirable in both the abducted and neutral positions of the scapula. If the amount of flexion in a fused shoulder is not more than 15 degrees, the weight of the arm will cause the scapula to lie flat against the chest wall, when only the trapezius is present. For this reason, flexion of the arm in a girl should be between 10 and 15 degrees. In a boy, flexion may be increased to 25 degrees for optimum functional use. Care must always be taken, however, to avoid excessive flexion, which will result in the winging of the scapula and the overstretching of the serratus anterior. Because of the normal variations in the curve of the chest wall, the degree of flexion is often an individual problem. In most patients, with the arm abducted 70 to 90 degrees, and forward about 35 to 40 degrees with the body planes, the resulting flexion is correct. A more accurate method would be to keep the scapula in the neutral position and bring the arm forward 15 to 25 degrees. It may be mentioned at this point that fusion without some flexion is always a most useless position for the arm.

Rotation: Proper rotation of the arm has not been sufficiently emphasized, judging from the cases observed in this study. It is felt, after checking the position of rotation at different angles of abduction, that this error is due largely to inaccuracy of descriptive terms. For example, what is believed to be a "slight external rotation" with the arm abducted to 90 degrees, is really internal rotation with the arm at the side. Rotation such that the "hand swings to the mouth" varies according to the degree of abduction. The "salute position", probably the most widely used term to describe the proper position for arthrodesing the shoulder, is a most misunderstood term.

Too great rotation and abduction at the shoulder joint has been the indication for numerous osteotomies to correct poor functional results. Too much external rotation of the arm is even worse than too much internal rotation. In only rare instances did the surgeon note the degree of rotation existing at the conclusion of the operation.

The most common complaint of the girls with fused shoulders, was the inability to fix their hair. With the arm in not more than 15 degrees of internal rotation, the hand can reach the top of the head without abducting more than 35 to 40 degrees. The ability to get the hand to the mouth was emphasized in many of the cases. It should be mentioned that girls are able to eat quite well with one hand, but it takes both hands to put up curls! A great deal more disability and impairment of function were observed following too much internal rotation.

Abduction of the humerus on the scapula of 45 to 50 degrees, with abduction of the arm from the body from 70 to 90 degrees, forward flexion from the scapula of 15 to 25 degrees, and a tilting upward of the flexed forearm 25 to 30 degrees above the horizontal constitutes the best position for fusion in the majority of cases. This position will result in about 25 degrees of internal rotation when the arm is brought down to the side. If the forearm is placed horizontal to the body when the arm is abducted, the resulting fusion will be 40 to 45 degrees of internal rotation. Greater internal rotation than this only results in a poor functional fusion.

In the presence of a weak elbow and hand, with the opposite extremity normal, the shoulder may be fused in greater internal rotation, but not over 45 degrees. On the other hand, too much external rotation causes difficulty in buttoning the vest and tucking in the shirt-tail. This difficulty is further aggravated whenever too much external rotation is combined with too much flexion.

Special Problems To Be Considered

The problem of arthrodesis of the shoulder in the presence of scoliosis requires special consideration. There were twenty-nine patients in a total of 148 examined, who gave a history of a preoperative scoliosis. At the time of the examination, the convexity of the curve in the upper thoracic region was toward the stronger shoulder in 66.7 per cent. of these cases. Only seven of the twenty-nine patients presented a severe curve, and in only one of these had the curve increased noticeably after arthrodesis. There was not sufficient evidence that the shoulder operation in itself had had any deleterious effect upon the scoliosis. In the twenty-nine cases, it was noted that the scoliosis limited considerably the range of motion in the scapula. In the presence of a severe curve, with the convexity toward the shoulder to be fused, care must be taken to avoid too much flexion of the arm. Otherwise, excessive winging of the scapula will result, and will accentuate the visible deformity.

We have tried to determine the age at which an arthrodesis is best done. The average age at which shoulder fusions were done in this study was twelve and one-half years. The youngest patient was six, and the oldest, thirty. Table I gives the ages at which a fusion was done and the results.

TABLE I

AGE OF 101 PATIENTS (102 SHOULDERS) AND RESULTS OF ARTHRODESIS

Age (*Years*)	No.	Non-Union	
		No.	Per Cent.
6	4	1	25
7	3	0	0
8	4	3	75
9	5	3	60
10	17	4	23.5
11	14	2	14.3
12	11	2	18.2
13	10	3	30
14	12	0	0
15	6	1	16.7
16	4	1	25
17 to 20	6	1	16.7
21 to 30	6	2	33.3
Total	102	23	22.5

This study did show that the range of motion is better in those patients in whom an arthrodesis had been done under the age of twelve, than in those of an older age group. It appears, also, that the danger of growth disturbance in operating on the shoulder in young children is more theoretical than real. Only one case of epiphyseal disturbance was seen following arthrodesis. This case was in a boy of eleven, who had previously had a trapezius transplant and a Nicola operation. An arthrodesis was done by the Steindler technique, with the addition of a Steinmann pin through the humeral head into the glenoid.

A bilateral arthrodesis was done in one case, because of two flail shoulders. We feel that if there had been sufficient muscle power for a transplantation on one side it might have been preferable. If it is necessary to fuse both shoulders, the position of fusion should allow the two hands to be brought together. If there is a difference

in muscle power in the two shoulders, the weaker one should be placed in more internal rotation. If the muscle power about the shoulders is essentially the same, the left shoulder in a right-handed person should have the greater degree of internal rotation, and *vice versa* for a left-handed individual.

In several instances, fusion of completely flail upper extremities gave satisfactory results. Four advantages for fusion under these circumstances were: ease of turning in bed; greater ease in getting into a coat; the ability to use the hand to steady a piece of paper while writing; and, lastly, an added feeling of stability or security in the shoulder. If only trapezius power was present, the patients preferred the fusion operation. In the presence of these flail or nearly flail extremities, a flexion contracture at the elbow was found to be of considerable benefit. One patient was seen in whom a flexorplasty of the elbow had been done. Although there had been no increase in the power of flexion, because the transplanted muscles were weak, the resulting flexion contracture at the elbow was of real value.

In weak or flail elbows, only slight abduction of the arm on the scapula is desirable, in order that the arm may come close to the side. In this type of disability, however, as much as 40 or 45 degrees of internal rotation was found desirable. It should also be mentioned that flexion power at the elbow frequently improved following stabilization of the shoulder.

Types of Operation

Regarding the type of operation, it appears that the technique employed in accomplishing the operation is not so important as the position and after-care. All of the operations for shoulder fusion gave good results, if the arm was placed in a satisfactory position for function, and if the postoperative care was adequate. The most popular operation throughout the country is that in which the acromion is thrust into a cleft in the head or neck region of the humerus, as described many years ago by Gill. Thirty-seven of the 102 arthrodeses in this series used this principle. In fifteen other patients, internal fixation was accomplished by using a bone graft, wires, nails, or screws. Your Committee feel that some type of joint fixation is desirable to lessen the danger resulting from movement between the humerus and the scapula within the plaster cast.

Postoperative Care

While it appears, at first glance, that there is a greater chance of non-union in attempting arthrodesis under the age of ten years, this study seems to show that this may be due to a shorter period of protection rather than to age.

The average time of immobilization in plaster, in all cases in which accurate records on this point were available, was only three and eight-tenths months. The shortest time in plaster was five weeks. Twenty-six of the patients were held in the casts two and one-half months or less. Of these, eleven, or 42 per cent., failed to obtain union. Forty-seven patients were in the casts three months or more. Of these, non-union developed in only eight, or 17 per cent. In four, or 67 per cent., of the six patients under ten years of age, who were kept in plaster less than two and one-half months, fusion failed. Of ten patients under ten years of age, who were kept in plaster three months or more, in only three, or 33 per cent., was there a failure of fusion. From the above, we would conclude that the time of immobilization may be more important than the age of the individual at the time of the operation.

In all patients examined, it appeared that, regardless of whether or not bony fusion occurred as demonstrated by roentgenograms, the joint became stabilized within five months after the operation. There may later prove to be exceptions to this statement as roentgenograms were not always available exactly five months after operation. However, we did find that, though the support was removed from the shoulder before the end of five months and union had not then occurred, the position of the shoulder remained unchanged after a five months' postoperative period. Therefore, we assumed that even if fusion had not occurred in the first five months, the fibrous ankylosis was then

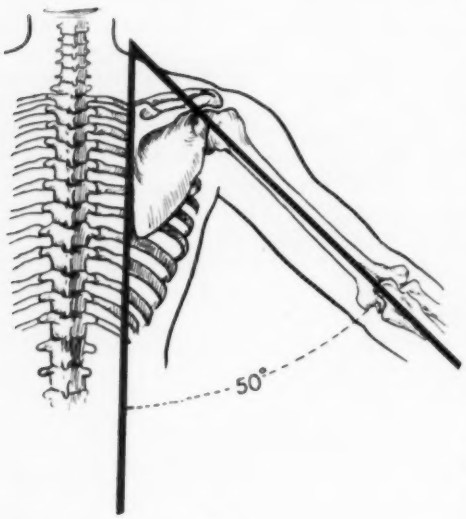

FIG. 1

Showing the recommended position of abduction of the skeleton from the back, with the scapula in the normal anatomical position, and the humerus abducted 50 degrees.

sufficient to maintain permanently this position of the joint. This is a valuable fact, if time substantiates this impression, because it means that proper plaster support for the arthrodesed shoulder is usually unnecessary for more than five months after operation. Our records show that the shoulder should be kept in plaster for a minimum of three months after the fusion operation. At the end of this time, if a roentgenogram does not show the beginning of bony fusion, a new plaster should be applied for an additional two months' period.

Another fact that has been revealed by this study—and this, without exception—is that, when we have roentgenographic evidence of the beginning of bony union, no further change in the angle of abduction will develop. Many of the cases lost between 10 and 20 degrees of the original abduction in the first five months, and then remained practically stationary. The exact time when bony union occurred appeared to vary considerably. One patient, who was immobilized for only three months, lost 15 degrees of abduction between the six weeks' and six months' postoperative periods, and, at the end of this time, non-union was still present. Two years later this patient presented solid bony fusion, without change in the position noted in the six months' postoperative roentgenogram. Another case was seen in which no evidence of fusion was visible in the roentgenogram eleven months postoperatively. Ten years later this patient presented solid bony union without any change in the abduction angle.

The use of an abduction splint for protection, after removal of the plaster, appears to be of questionable value. Whenever the plaster was left on for the required five months' period, a splint was found to be unnecessary. In view of this observation, some doubt might be cast on the use of an abduction splint for such excessively long periods as were encountered. In one case, a fifteen-year-old boy, who had had infantile paralysis when three years of age and who had worn a brace for ten out of the twelve years since the onset of the disease, was still wearing it twenty-two months after operation, although he presented a solid fusion. Another patient was found wearing a brace nineteen months after operation, although the roentgenogram twelve months previously had shown bony union.

There has been the impression that firm fibrous union of the shoulder is as satisfactory as bony union. This opinion needs qualification. In most of the cases of non-union, very little actual abduction was present between the scapula and the humerus, and this resulted in a poor range of scapular motion. The trace of motion in the shoulder joint proper that was found in these patients, frequently caused pain or a sense of fatigue. Therefore, we feel that a firm fibrous union is rarely as satisfactory as a solid bony union.

II. MUSCLE TRANSPLANTATIONS

Forty-three patients had sixty-two operations. Though there were subsequent operations on a number of shoulders, no bilateral transplantations were found. Of the transplantations, a total number of twenty-nine consisted of transference of the

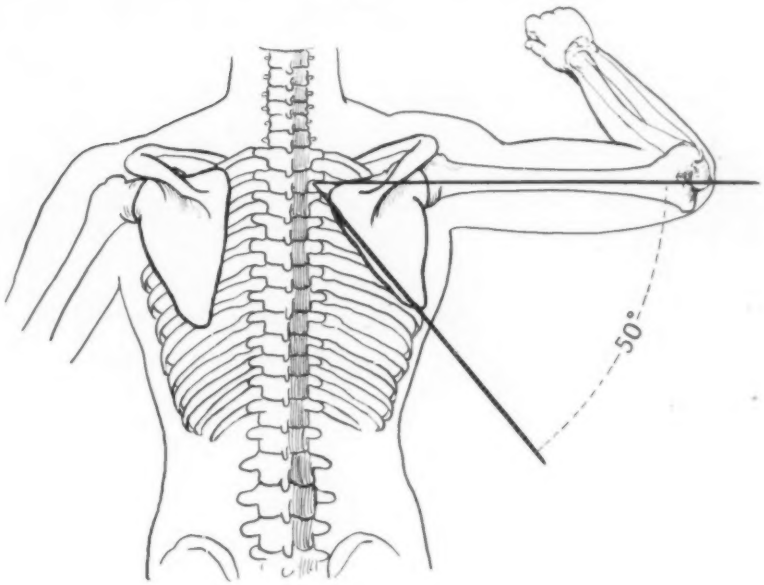

FIG. 2

View from the back showing position of postoperative fixation; and relation of the scapula to the humerus, and of the arm to the trunk.

short head of the biceps and the long head of the triceps to the acromion, or some modification of this technique as described by Ober. Some of these transplantations were combined with other operations to meet particular indications. There were thirteen Nicola operations done in conjunction with some other transplantations.

In considering the total forty-three patients with transplantations, sixteen showed no improvement. Eighteen presented only slight improvement, consisting of an increased stability with little or no increase in the range of motion or strength in the joint. In eight of the total number, it was found that the muscle transplantation gave a better result than could have been obtained by any other type of surgery. The operations performed in these patients were equally divided between the Ober and the Mayer types of operation. In *none* of these eight patients was the deltoid *completely* paralyzed. In the Ober operation, contraction of the transplanted biceps in the absence of a deltoid seemed to lock the humerus to the scapula by a direct, upward pull, and the patient was unable to initiate abduction at the scapulohumeral joint.

In the Mayer procedure, the transplanted trapezius pulled upon its fascial prolongation, which often became attached to the acromion by adhesions, holding the humerus abducted. This fascial strip, therefore, acted only as a check ligament when the scapula was actively rotated upward.

An example of the action of the transplanted biceps and triceps was seen in a somewhat exaggerated form in one case. The strong pectoralis major pulled the head of the humerus down against the rim of the glenoid, after which the hypertrophied transplanted triceps locked it in this position. Abduction to 80 degrees occurred by rotation of the scapula, giving an unusual degree of motion, but when the humerus was passively held in the glenoid, the patient could not abduct the arm.

Three patients were seen in whom the strong posterior deltoid was shifted forward to the acromion and outer end of the clavicle, to act as an abductor. One of these attained an excellent result, while the others had only fair results. This procedure would appear to be an excellent one in selected cases. Even though the deltoid may be some-

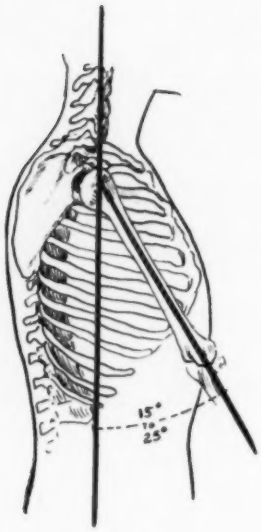

FIG. 3

Showing recommended flexion from the side, with scapula in the normal anatomical position.

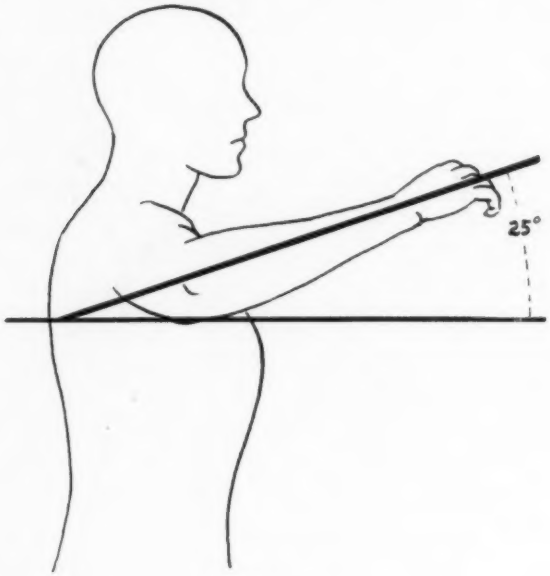

FIG. 4

Showing the postoperative position from the side, and illustrating flexion and rotation.

what weakened following operation, it is in a much better position for the abduction movement.

The time of postoperative support following operations for muscle transplantations varied a great deal, irrespective of the clinic. Some patients discarded all support after six weeks, and others kept the abduction splint on for years. One twelve-year-old child had worn a brace four years before operation, and was still wearing it seven and one-half years after a muscle transplantation, but apparently without benefit. Another child wore a brace eight years after operation.

In some of the cases, there was a loss of power in the biceps and triceps after transferring them to the acromion. This was so marked in several instances, that the ability to flex the elbow against gravity was lost, although, before surgery, there had been a satisfactory degree of muscle power in the biceps. This was also noted in a few cases following trapezius transplantations.

The statement that, if a transplant fails, one can always do an arthrodesis, must be questioned. Eighteen patients had a total of twenty-seven transplant operations before arthrodesis of the shoulder. There was a demonstrable lack of freedom of motion in the scapula in these patients, compared with those in whom the arthrodesis was the primary operation.

Two cases were seen in which the Nicola operation had been done to correct subluxation in paralytic shoulders. There was slight improvement in one, but in the other there was not sufficient improvement to justify the operation. We question the advisability of using this procedure for correcting a subluxation which occurs as the result of infantile paralysis.

One case was seen in which an attempt was made to stabilize both shoulders by tying the scapulae together with a strip of fascia without, however, any demonstrable benefit.

CONCLUSIONS

1. *Arthrodeses of the Shoulder*

This survey would indicate that an arthrodesis of the shoulder joint is the operation of choice in all cases of infantile paralysis with complete paralysis of the deltoid. An

upper trapezius with only fair power was found to be the only muscle which *must* be present. If both trapezius and serratus anterior are present, a satisfactory range of motion and power should be obtained. The operation should result in improved function of the upper extremity with little loss of cosmetic effect.

The optimum position of fusion was found in most cases to be 45 to 55 degrees of abduction, 15 to 25 degrees of flexion, and 15 to 25 degrees of internal rotation. A correct degree of rotation was found to be more important from a functional standpoint than the degree of abduction (Figs. 1, 2, 3, and 4).

Postoperative fixation in plaster from a minimum of three months to a maximum of five months appeared sufficient. A fusion operation can be done any time after the age of six years. While in the younger patients, a better range of motion developed, the percentage of failure of fusion was found to be consistently higher.

2. *Muscle Transplantations at the Shoulder*

The satisfactory muscle transplantations were found only in those cases possessing fair power in the deltoid preoperatively.

JOSEPH S. BARR, M.D., *Chairman*
JOSEPH A. FREIBERG, M.D.
PAUL C. COLONNA, M.D.
PAUL A. PEMBERTON, M.D., *Research Fellow*

News Notes

Dr. Arthur Steindler, Professor of Orthopaedic Surgery, State University of Iowa, has been honored by the National University of Mexico by being made Professor of Orthopaedic Surgery. This nomination makes him an extramural member of the medical faculty of this University. He has also been made an honorary member of several medical societies in Mexico.

Dr. Dudley M. Stewart announces the removal of his office to the Professional Building, 1838 Parkwood Avenue, Toledo, Ohio.

The annual meeting of the United States Chapter of the **International College of Surgeons** is to be held in Denver, Colorado, July 15 to 18.

The Fourth Annual Session of **The American Association for the Surgery of Trauma** was held in Boston on June 4, 5, and 6 under the presidency of Dr. Henry C. Marble. An excellent program was presented. The president for the coming year is Dr. Charles S. Venable of San Antonio, Texas.

The **Biological Photographic Association** will hold its Twelfth Annual Convention in New York City, September 10, 11, and 12. Information may be obtained from the Chairman, Mr. Joseph Haulenbeek, Rockefeller Institute for Medical Research, New York.

The Second Annual Meeting of the **New England Society of Bone and Joint Surgery** was held at the Hartford Golf Club, Hartford, Connecticut, on June 19. The newly elected officers are: President, Dr. Allan Woodcock, Bangor, Maine; Vice-President, Dr. G. E. Haggart, Boston; and Secretary-Treasurer, Dr. Gordon M. Morrison, Boston. Dr. John H. Sweet, Jr., of Hartford, was made an Honorary Member. The next Annual Meeting is scheduled to be held in May 1943, in Bangor.

Annals of Surgery is now available in Spanish. Beginning with the issue of June 1942, that journal is to be published simultaneously in Philadelphia, by J. B. Lippincott Company, and in Buenos Aires, by the Guillermo Kraft Company.

It is significant that this excellent journal of surgery, established in 1885 by Dr. Lewis Stephen Pilcher, who was Editor for fifty years, should take this important step. The fact that there is a call for a Spanish translation of the *Annals* is indicative of the growing interest of the surgeons of the Americas in each other's problems. The medical profession in this country has become increasingly aware of its obligations and responsibilities in South America. No better symbolic demonstration can be given of its sincere willingness to develop permanent intellectual fraternization between the surgeons of the two continents.

THE BRITISH ORTHOPAEDIC ASSOCIATION

The British Orthopaedic Association held its Spring Meeting in Liverpool, May 29 and 30. The principal subjects of discussion were as follows:

Delayed Union of Fractures in the Lower Limb.

Mr. George Perkins (Ministry of Pensions).

Mr. R. Watson-Jones and Sq.-Ldr. W. D. Coltart (R.A.F.).

Mr. B. H. Burns (E.M.S.).
Major W. White (R.C.A.M.C.).
Dr. E. Harlan Wilson (American Hospital in Britain).

Methods of Amputation in the Lower Limb: a Comparison of Canadian and British Experience.
Dr. A. B. LeMesurier (Toronto).
Dr. R. D. L. Kelham (Ministry of Pensions, Roehampton).

Other papers presented were:

Transtrochanteric Fracture of the Femur.
Mr. N. L. Capener.

Rate of Regeneration of Peripheral Nerves.
Prof. H. J. Seddon.

Fractures of the Femur.
Mr. W. S. Diggle.

Air Arthrography in Lesions of the Semilunar Cartilages.
Mr. C. H. Cullen and Dr. G. Q. Chance.

The afternoon of the first day was devoted to a visit to the Rehabilitation Centre, Hoylake, by courtesy of the Air Ministry.

The Association Dinner was held at the Adelphi Hotel on the evening of May 29.

THE AMERICAN ORTHOPAEDIC ASSOCIATION

The Fifty-Sixth Annual Session of The American Orthopaedic Association, under the Presidency of Dr. George E. Bennett, was held in Baltimore, on June 3, 4, 5, and 6, 1942. The headquarters were at the Lord Baltimore Hotel.

On the first day, Wednesday, a clinical program was presented in Hurd Memorial Hall, Johns Hopkins Hospital, by the following surgeons: Dr. George O. Eaton, Dr. John Lyford, III, Dr. Moses Gellman, Dr. Harold R. Bohlman, Dr. I. William Nachlas, Dr. Winthrop M. Phelps, Dr. Edwin D. Weinberg, and Dr. Allen F. Voshell.

At noon, Dr. Kellogg Speed read a paper on "Post-Metastatic Survival of Osteogenic Sarcoma", with discussion opened by Dr. J. Albert Key.

After luncheon at the Great Hall, Welch Library, the Annual Golf Tournament was held at the Elkridge Club, followed by the Golf Dinner. During the afternoon, Dr. Winthrop M. Phelps held Open House at the Children's Rehabilitation Institute. The Curative Workshop at the Johns Hopkins Hospital and the Physiotherapy Department at the Children's Hospital School were also visited by many of the members and guests.

Beginning with Thursday morning, the following program was presented:

THURSDAY, JUNE 4

Morning Session

Tangential Fracture of the Patella.
Dr. J. E. Milgram, Brooklyn, New York.
Discussion: Dr. Samuel Kleinberg, New York, N. Y.

Modified Operation for Opponens Paralysis.
Dr. T. Campbell Thompson, New York, N. Y.
Discussion: Dr. Leo Mayer, New York, N. Y.
Dr. Alan DeForest Smith, New York, N. Y.
Dr. J. Albert Key, St. Louis, Missouri.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.
Dr. T. Campbell Thompson, New York, N. Y.

Spondylolisthesis.
Dr. Henry W. Meyerding, Rochester, Minnesota.
Discussion: Dr. R. I. Harris, Toronto, Ontario.
Dr. Edwin W. Ryerson, Chicago, Illinois.

Dr. Elmer P. Weigel, Plainfield, New Jersey.
Dr. Samuel Kleinberg, New York, N. Y.
Dr. J. Albert Key, St. Louis, Missouri.
Dr. Henry W. Meyerding, Rochester, Minnesota.

The Healing of Fractures.
Dr. Robert W. Johnson, Jr., and (by invitation) Dr. Marshall R. Urist, Baltimore, Maryland.
Discussion: Dr. William E. Gallie, Toronto, Ontario.
Dr. Robert W. Johnson, Jr., Baltimore, Maryland.
Dr. George E. Bennett, Baltimore, Maryland.

Metal Internal Fixation in Lumbosacral Fusion.
Dr. Philip D. Wilson, New York, N. Y.
Discussion: Dr. Alan DeForest Smith, New York, N. Y.
Dr. Mather Cleveland, New York, N. Y.
Dr. Philip D. Wilson, New York, N. Y.

Malignant Vascular Tumors of Bone.
Dr. Atha Thomas, Denver, Colorado.

Afternoon Session

Management of Wounds of the Extremities in Modern Warfare.
Col. J. A. MacFarlane, R.C.A.M.C., Surgical Consultant to the Canadian Active Service Force. (By invitation.)

Orthopaedic Surgery in the Naval Medical Service.
Capt. F. R. Hook, U.S.N., Washington, D. C. (By invitation.)

Immersion Foot.
Lt. Comdr. D. R. Webster, Halifax, Nova Scotia. (By invitation.)

Pin Fixation in War Fractures.
Dr. Wallace H. Cole, St. Paul, Minnesota.

Report of the Combined Military Committees of The American Orthopaedic Association and The American Academy of Orthopaedic Surgeons.
Dr. Guy W. Leadbetter, Chairman, Washington, D. C.

Chemotherapy in the Treatment of Wounds.
Dr. Perrin H. Long, Baltimore, Maryland. (By invitation.)

FRIDAY, JUNE 5

Morning Session

End Results of Treatment of Poliomyelitis in Baltimore.
Dr. Raymond E. Lenhard, Baltimore, Maryland. (By invitation.)

End Results of Treatment of Poliomyelitis in Detroit.
Dr. Charles W. Peabody, Detroit, Michigan.

End Results of Operative Treatment of Poliomyelitis.
Dr. Isadore Zadek, New York, N. Y.

Departures from the Principle of Absolute Fixation in the Treatment of Anterior Poliomyelitis.
Dr. Arthur Steindler, Iowa City, Iowa.

Spasticity of Muscles in Anterior Poliomyelitis.
Dr. R. Plato Schwartz, Rochester, New York.
Discussion of the five foregoing papers:
Dr. Wallace H. Cole, St. Paul, Minnesota.
Dr. Frank R. Ober, Boston, Massachusetts.
Dr. H. R. McCarroll, St. Louis, Missouri.
Dr. Charles LeRoy Lowman, Los Angeles, California.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Indications for the Intravenous Use of Amino Acid Mixtures in Surgery.
Dr. Lee E. Farr, Wilmington, Delaware. (By invitation.)
Discussion: Dr. L. Emmett Holt, Jr., Baltimore, Maryland. (By invitation.)
Dr. A. R. Shands, Jr., Wilmington, Delaware.
Dr. Lee E. Farr, Wilmington, Delaware.

Method of Measuring Strength of Trunk Muscles.
Dr. Leo Mayer and (by invitation) Dr. Benjamin B. Greenberg, New York, N. Y.
Discussion: Dr. Arthur Steindler, Iowa City, Iowa.
Dr. Leo Mayer, New York, N. Y.

Arthrodesis of Wrist Joint.
Dr. LeRoy C. Abbott, Dr. Frederic C. Bost, and (by invitation) Dr. John B. deC. Saunders, San Francisco, California.
Discussion: Dr. J. Albert Key, St. Louis, Missouri.
Dr. Compton Riely, Baltimore, Maryland.
Dr. LeRoy C. Abbott, San Francisco, California.

Mechanics of the Arch of the Foot.
Dr. Paul W. Lapidus, New York, N. Y. (By invitation.)
Discussion: Dr. R. Plato Schwartz, Rochester, New York.
Dr. Isadore Zadek, New York, N. Y.
Dr. Leo Mayer, New York, N. Y.
Dr. Paul W. Lapidus, New York, N. Y.

Afternoon Session

President's Address.
Dr. George E. Bennett, Baltimore, Maryland.

Compound Fractures.
Dr. Arthur G. Davis, Erie, Pennsylvania.
Discussion: Dr. H. Earle Conwell, Birmingham, Alabama.
Dr. Leo Mayer, New York, N. Y.
Dr. R. I. Harris, Toronto, Ontario.
Dr. Arthur G. Davis, Erie, Pennsylvania.

Fractures of the Odontoid Process.
Dr. W. E. Gallie, Toronto, Ontario.
Discussion: Dr. Frederick A. Jostes (read by the Secretary).
Dr. William G. Turner, Montreal, Quebec.
Dr. Fred H. Albee, New York, N. Y.
Dr. Paul B. Steele, Pittsburgh, Pennsylvania.
Dr. W. E. Gallie, Toronto, Ontario.

End Results of Bloodless Reduction of Congenital Dislocation of the Hip.
Dr. A. Bruce Gill, Philadelphia, Pennsylvania.
Discussion: Dr. Clarence H. Heyman, Cleveland, Ohio.

Spontaneous Fracture of the Neck of the Femur Following Radiation Treatment for Pelvic Malignancy.
Dr. Carl E. Badgley and (by invitation) Dr. Harold Bowman, Ann Arbor, Michigan.
Discussion: Dr. W. E. Gallie, Toronto, Ontario.
Dr. Carl E. Badgley, Ann Arbor, Michigan.

Osteomyelitis and Its Treatment by Sulfonamide Drugs.
Dr. John C. Wilson and Dr. Francis M. McKeever, Los Angeles, California.
Discussion: Dr. D. E. Roberston, Toronto, Ontario.
Dr. Benjamin P. Farrell, New York, N. Y.
Dr. I. William Nachlas, Baltimore, Maryland.

SATURDAY, JUNE 6

Morning Session

Etiology of Aseptic Necrosis of Head of Femur Following Fractures.
Dr. Edward L. Compere, Chicago, Illinois.
Discussion: Dr. J. Albert Key, St. Louis, Missouri.
Dr. Edward L. Compere, Chicago, Illinois.

The Use of Steel Wires for the Retention of Bone Fragments.
Dr. A. W. Farmer, Toronto, Ontario.
Discussion: Dr. J. S. Speed, Memphis, Tennessee.
Dr. R. I. Harris, Toronto, Ontario.

Repair of Complete Acromioclavicular Dislocation with the Aponeurosis of the Short Head of the Biceps.
Dr. Luthero Vargas, Rio de Janeiro, Brazil. (By invitation.)
Discussion: Dr. Carl E. Badgley, Ann Arbor, Michigan.
Dr. Luthero Vargas, Rio de Janeiro, Brazil.

Local Anaesthesia in Spine Surgery.
Dr. Joseph A. Freiberg, Cincinnati, Ohio.
Discussion: Dr. J. H. Kite, Decatur, Georgia.
Dr. Henry W. Meyerding, Rochester, Minnesota.
Dr. Joseph A. Freiberg, Cincinnati, Ohio.

A Survey of End Results on Stabilization of the Paralytic Shoulder. Report of the Research Committee of The American Orthopaedic Association.
Read by Dr. Paul C. Colonna, Oklahoma City, Oklahoma.
Discussion: Dr. A. Bruce Gill, Philadelphia, Pennsylvania.

Refrigeration Anaesthesia for War Injuries of the Extremities.
Dr. Frederick M. Allan (by invitation) and Dr. Lyman W. Crossman (by invitation), New York, N. Y.
Discussion: Dr. Philip D. Wilson, New York, N. Y.
Dr. Lyman W. Crossman, New York, N. Y.

Executive Sessions were held at noon on Thursday and on Saturday.

Dr. and Mrs. Bennett entertained the members and guests at a reception and buffet dinner at the Elkridge Club on Thursday, and the Annual Dinner of the Association was held at the Lord Baltimore Hotel, Friday evening.

Dr. Frank R. Ober, Boston, Massachusetts, is President of the Association for the year 1942–1943.

At the Executive Session, the following new officers and members of committees were elected:

Officers

President-Elect: Dr. A. Bruce Gill, Philadelphia, Pennsylvania.
Vice-President: Dr. John Dunlop, Pasadena, California.
Secretary: Dr. Charles W. Peabody, Detroit, Michigan.
Treasurer: Dr. Frank D. Dickson, Kansas City, Missouri.

Committee members and delegates

Membership Committee: Dr. H. Earle Conwell, Birmingham, Alabama.
Program Committee: Dr. Lloyd T. Brown, Boston, Massachusetts.
Delegate to the American College of Surgeons: Dr. Edwin W. Ryerson, Chicago, Illinois.
Representatives on the American Board of Orthopaedic Surgery:
Dr. LeRoy C. Abbott, San Francisco, California.
Dr. Harold H. Hitchcock, Oakland, California.

At this Meeting, the following were received into membership:

Active members

Dr. William T. Green, Boston, Massachusetts.
Dr. Keene O. Haldeman, San Francisco, California.
Dr. Jacob Kulowski, St. Joseph, Missouri.
Dr. Joseph B. L'Episcopo, Brooklyn, New York.
Dr. Henry R. McCarroll, St. Louis, Missouri.
Dr. Robert G. Packard, Denver, Colorado.
Col. Jesse I. Sloat, Atlanta, Georgia.

Corresponding members

Mr. R. Watson-Jones, Liverpool, England.
Mr. H. J. Seddon, Oxford, England.

Due to existing conditions, the Meeting, originally scheduled to include sessions at Virginia Beach, was held entirely at Baltimore. That the necessary changes were made, and the plans for the Meeting so successfully carried out, was due in large measure to the efforts of the President, Dr. Bennett, and to the local committee of which Dr. Robert W. Johnson, Jr., was Chairman. Dr. I. William Nachlas was in charge of entertainment, and Dr. Allen F. Voshell, of the golf tournament and dinner. Dr. R. I. Harris, of Toronto, was Chairman of the Program Committee.

ACKNOWLEDGMENTS

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Americana Clinica (New York, N. Y.), III, Nos. 4 and 5, 1942.

Anais Paulistas de Medicina e Cirurgia (São Paulo, Brasil), XLII, Indice, 1941; XLIII, Nos. 1, 2, and 3, 1942.

Medical Statistics Bulletin No. 1. Analysis of Reports of Physical Examination. Summary of Data from 19,923 Reports of Physical Examination. Washington, D. C., National Headquarters, Selective Service System. November 10, 1941.

Boletim do Sanatorio São Lucas (São Paulo, Brasil), III, Nos. 7, 8, and 9, 1942.

Boletin del Colegio Medico de la Habana (Cuba), V, Nos. 4 and 5, 1942.

Bulletin of the Hospital for Joint Diseases (New York, N. Y.), III, No. 2, 1942.

Cleveland Clinic Quarterly, IX, No. 2, 1942.

Georgia Warm Springs Foundation. Annual Report for the Fiscal Year Ended September 30, 1941.

Harper Hospital Bulletin (Detroit, Michigan), I, Nos. 6 and 8, 1942.

Médica (Matanzas, Cuba), I, Núms. 2 and 3, 1942.

The Merck Institute for Therapeutic Research (Rahway, New Jersey), 1942.

University of Pennsylvania Bulletin. Graduate School of Medicine. The Medico-Chirurgical College. Announcement for Session 1942–1943 (XLII, No. 33). Philadelphia, 1942.

La Prensa Médica Mexicana (México, D. F.), VII, Núms. 3, 4, and 5, 1942.

Proceedings of the Staff Meetings of the Mayo Clinic (Rochester, Minnesota), XVII, Nos. 15, 16, 17, and 18, 1942.

Respirators. Locations and Owners. April 1, 1942. New York, The National Foundation for Infantile Paralysis, Inc., 1942.

Revista Cubana de Obstetricia y Ginecologia (La Habana, Cuba), IV, Nos. 2 and 3–4, 1942.

Revista Médica Municipal, III, Núm. 1, 1942.

Roche Review (Nutley, New Jersey), VI, Nos. 8 and 9, 1942.

The Rockefeller Foundation. A Review for 1941. By Raymond B. Fosdick. New York, 1942.

Vida Nueva (Habana, Cuba), XLIX, Nos. 1, 2, and 3, 1942.

Current Literature

INTERNAL MEDICINE IN OLD AGE. Albert Mueller-Deham, M.D., and S. Milton Rabson, M.D. Baltimore, Williams and Wilkins Co., 1942. $5.00.

Geriatrics is coming to the front in medical literature, and in this volume by Mueller-Deham and Rabson is a very comprehensive review of the bone, joint, and muscle lesions not uncommonly met with in elderly individuals.

Due to the war and other causes, it is estimated that in the next decade the number of inhabitants of this country above sixty-five years of age will have increased tremendously. Consequently the science of geriatrics is bound to be called upon to aid in prolonging the efficiency of the aged.

Citation of the great numbers of arthritic patients in this country and elsewhere emphasizes the fact that this is preeminently a disease of late adult life, and, therefore, one in which geriatrics is much concerned. Considerable space is devoted to the discussion of the types of chronic arthritis, which adheres pretty closely to the present-day classification. In the matter of treatment there was nothing added to present knowledge.

The descriptions of the onset and course of the diseases and the tissue changes that characterize them are very clearly set forth. Among the most interesting are osteoporosis, Paget's disease, osteomalacia, von Recklinghausen's disease, tuberculosis, syphilis, myositis, and other lesions of the muscles and ligaments. These are taken up and discussed briefly, but adequately. So far as treatment is concerned geriatrics is not at present, at least, in a position to do much more than cite the diseases most prevalent among the aged. Unless something pretty dramatic along the lines of treatment is forthcoming, it will be a good deal of a question how much interest the aged will manifest in the new specialty. They will be pretty much inclined to believe that the biblical author was right in what he said about life beyond three score and ten.

However, it is an interesting volume and contains much valuable information presented in an entertaining manner.

A TEXTBOOK OF SURGERY. American Authors. Edited by Frederick Christopher, M.D. Ed. 3. Philadelphia, W. B. Saunders Co., 1942. $10.00.

The third edition of A Textbook of Surgery serves to bring up to date this book which sets a standard for textbooks of surgery for teaching and review purposes. The book is 1,718 pages in length, and contains 1,538 illustrations. There are 195 separate authors contributing to the work, almost all of whom are leaders in American surgery in various fields. The work represents an outstanding accomplishment in presenting a consensus of opinion in American surgery in summary form, and shows an enormous amount of effort in careful preparation to cover the entire field of surgery.

The book is divided into forty chapters, each chapter representing a section. Several chapters deal with the general basic principles and subjects in surgery, and toward the end of the book several other chapters deal with related subjects,—such as anaesthesia, and preoperative and postoperative care.

A section has been added to this edition of the book on the subject of war injuries, and deals with the types of injuries and their treatment. A brief mention of chemotherapy with the sulfonamide compounds is made, and a great deal of stress is laid on the Orr-Trueta method of treatment of fresh war injuries. Every specialty in the realm of surgery is represented by a section or chapter by outstanding American authorities, and the book seems an ideal one for the medical student. Of special interest to those interested in orthopaedic surgery are the chapters dealing with tendons, muscles and ligaments, bursae, orthopaedic surgery, amputations and prostheses, the bones, and frac-

tures and dislocations,—a total of seven chapters. The chapter on orthopaedic surgery requires almost exactly 100 pages, with many of the outstanding men in the specialty contributing parts of the section. It is presented in short and almost outline form, but is quite comprehensive enough for the medical student or the general practitioner who wants to look up something quickly, and find it in the form of a summary. The chapter on fractures is long, and about half of it is written by general surgeons rather than by orthopaedic surgeons; in a few places there are small points to which the orthopaedic surgeon might take exception. However, since the book is presented for the use of medical students and general men, great care has been used by the authors to keep the book as non-technical as possible; this is probably responsible for the method in which the treatment of some of the fractures is handled. It is most remarkable that a book, which is written by such a large number of authors, with the chapters divided into small sections, each distinct in itself, could at the same time include almost every conceivable subject in general surgery. It is sincerely felt that this textbook is a masterpiece, as far as being useful for the purpose for which it was prepared, and it should be on the shelf of every doctor for quick reference in any field of surgery with which he is not particularly familiar.

ARCHITECTURAL PRINCIPLES IN ARTHRODESIS. H. A. Brittain, M.A., M.Ch., F.R.C.S. With a Foreword by Harry Platt, M.D., M.S., F.R.C.S., F.A.C.S. (Hon.) Baltimore, The Williams and Wilkins Company, 1942. $6.00.

The author has considered the subject of arthrodesis from a somewhat new point of view, and has developed his methods on architectural principles. His theory is certainly sound, especially as to stiffened joints which are to be the seat of strain. He has illustrated how the mechanical principles employed in cathedral structures can be applied in this surgery.

In his general discussion, in which he gives the indications for arthrodesis, he enumerates the usual causes of failure of success in arthrodesis, as: (1) inadequate apposition, (2) inadequate immobilization, (3) extension of disease, and (4) operations based on faultily conceived mechanical principles. He then presents the architectural principles which should be employed, and shows how they may be applied. The rules which he advocates are: (1) the graft should be placed with its long axis in compression rather than in tension, (2) the breadth of the graft should be placed in the position of maximum stress, (3) the joint should be locked by two grafts crossing each other in the shape of the letter X, and (4) there should be adequate protection of the graft. The employment of the force of compression rather than of tension makes use of a sound principle.

Each joint is described in detail, and the author shows in what way he has applied architectural principles in placing the graft to most effectively resist stress. With this is given the technique of operation, and excellent illustrations of the surgical anatomy of the region, also of the special method of shaping and removing the graft as well as preparing the bed for it.

The application of this principle in some of the joints is particularly ingenious. In the hip he has fulfilled Calvé's contention that the ideal graft of the hip should be based as an adduction buttress. The chip-graft method of spinal arthrodesis is also deserving of special comment.

Although small, the book is beautifully illustrated, including a number of colored prints. The author has made a definite contribution to this difficult problem.

THE PRINCIPLES OF ANATOMY AS SEEN IN THE HAND. Frederic Wood Jones. Ed. 2. Baltimore, The Williams & Wilkins Co., 1942. $7.50.

The first edition, written during the excitement of the first World War, was published in 1920. The second edition has been prepared under similar conditions. The

entire text has been rewritten, and six chapters have been added. No pathological conditions are discussed.

The author feels that exact anatomy has not been given the attention that other branches of medicine have received. Physicians called upon to treat war injuries have begun to realize their need of anatomical knowledge. "War surgery is practical anatomy." A study of the anatomy of the hand brings out many principles which apply to other parts of the body.

A consideration of the comparative anatomy of primates helps to explain the development and physiological function of the hand.

Flexure lines are anatomical structures having definite relations to physiological functions. One must realize that, because of the presence of muscles and ligaments interposed between the joints and the skin, the flexure lines do not always mark the line of the joints. This point is demonstrated by reference to parts of the body other than the hand.

Excellent chapters have been written on cleavage lines, the papillary ridges, nails, and hairs. The fascia, bones, extrinsic and intrinsic muscles, joints, nerves, lymphatics, vessels, and sympathetic system have been discussed in great detail.

The illustrations in all chapters are excellent. Shaded drawings picture the nerve supply to various parts of the hand, the palmar arches, the tendon sheaths, the muscles, and the joints.

It is surprising that so much could be written on normal anatomy. Certainly, nothing of importance has been omitted.

DIRECTORY OF MEDICAL SPECIALISTS CERTIFIED BY AMERICAN BOARDS, 1942. New York, Columbia University Press, 1942. $7.00.

The publication of this Directory so soon after the 1939 edition was made necessary by the fact that to the 14,000 Diplomates listed then, there have been added 4,000 additional, together with three new Boards, bringing the total number of Boards up to fifteen. The volume contains a biographical notation on every Diplomate, listed by state, town or city (in Canada by province and city), an alphabetical list, the names of the officers of each of the several Boards, and the qualifications to be met by those who aspire to certification.

As a reference book for those called upon to pass on the qualifications of any specialist, whether for personal or public service, this is a valuable aid.

LESIONES TRAUMÁTICAS DE LOS MENISCOS, LIGAMENTOS CRUZADOS Y LIGAMENTOS LATERALES DE LA RODILLA (Traumatic Lesions of the Meniscus and Cruciate and Lateral Ligaments of the Knee). José Valls. Buenos Aires, Caporaletti Hnos., 1941.

In this monograph Dr. Valls reviews the anatomy and traumatic pathology of the meniscus, cruciate ligaments, and lateral ligaments of the knee. He discusses and favors the belief that there is frequently a predisposition to tearing of the meniscus. This often comes from repeated minor traumata which lead to degenerative changes. He has studied carefully 200 cases of traumatic lesions of the meniscus, but has been unable to evaluate the exact importance of these degenerative processes in the meniscus. Reparative processes in the meniscus divided themselves into two types,—vascularization and fibrous repair. Complete repair was observed in one case. Degenerative changes were observed most frequently in mountainous regions and in people who had to do much climbing. Arthritis deformans frequently followed a lesion of the meniscus. As the injuries to the meniscus may vary greatly, so the mechanism producing the injury may also differ greatly. In a review of 373 clinical cases, the author found longitudinal ruptures in 53 per cent., ruptures of the anterior portion in 15 per cent., a tear at the capsular attachment in 10 per cent., transverse rupture in 5 per cent., and a variety of lesions in the remainder.

All of the diagnostic signs reported in the literature are reviewed. The author believes that roentgenographic examination after the injection of air is helpful. Arthroscopy has not been helpful, since too small a part of the articulation is seen. In 373 cases, arthritis was found in nine, osteochondritis in three, and rupture of the anterior cruciate ligament in three. The author discusses both conservative and operative treatment. He has found partial removal of the meniscus adequate. In dogs operated upon seven to nine months after partial extirpation of the meniscus, almost complete regeneration was observed. The meniscus was removed in twenty-two children. In twelve of these, congenital abnormalities of the internal meniscus were found. After operation in children, there is usually instability which disappears gradually.

The mechanism of producing tears of the cruciate ligaments is discussed—the chief factor being rapid rotation of the body with the knee fixed. Genu recurvatum leads to stretching of the cruciate ligaments. The author feels that no physical signs are always reliable in making a diagnosis, but that anteroposterior and lateral instability are of most value. There is a difference of opinion in regard to the importance of the cruciate ligaments. But in most instances the author has found rupture of one of them to lead to instability, hydrarthrosis, and muscle atrophy. If symptoms are not severe, conservative treatment may be followed,—such as immobilization in semiflexion for two months, with heat, massage, and exercise. The author believes that healing has occurred by such treatment in seven cases. The author has replaced the ligament by silk sutures which followed almost the same course as the original ligament. Lesions of the lateral ligaments are also repaired by long silk sutures.

The monograph is well illustrated and there is a complete review of all the pertinent literature.

FRACTURES OF THE PELVIS. WITH SPECIAL REFERENCE TO ASSOCIATED FRACTURES OF THE SACRUM. Warren W. Furey. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 89, January 1942.

An analysis of ninety-six pelvic fractures occurring in a five-year period is presented. The sacrum was involved in sixty-five of these cases, automobile accidents being responsible for most of them. In accidents where the pelvis is fractured anteriorly, a sacral fracture may be easily overlooked. Since the percentage of posterior pelvic fractures in published reports is rather low compared with this series of cases, the author urges a deliberately thorough study of the sacrum in all cases of pelvic injury.
—*Richard C. Batt, M.D., Berlin, New Hampshire.*

TIME OF APPEARANCE AND FUSION OF OSSIFICATION CENTERS AS OBSERVED BY ROENTGENOGRAPHIC METHODS. H. Flecker. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 97, January 1942.

This lengthy article contains detailed statistical information about normal epiphyseal development. Much of this data, especially that concerning the sesamoids and smaller bones, is difficult to find in the reference charts and textbooks commonly used by specialists.

The author comments on the striking discrepancy among anatomical authorities on epiphyseal development. Despite previously published data, a really comprehensive roentgenographic survey of the time of appearance, and the fusion of centers of ossification and epiphyses has not yet been undertaken. It is asserted that all tables of ossification contain many inaccuracies due to insufficient quantitative information.

His own figures on ossification were obtained from roentgenograms of patients in the Prince Henry Hospital and Women's Hospital in Melbourne. He modestly considers this material insufficient for graphing and therefore prefers to present the actual figures for each age group and each epiphysis in sixty detailed tables.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

POST-TRAUMATIC PAINFUL OSTEOPOROSIS. A CLINICAL AND ROENTGENOLOGICAL ENTITY. Louis G. Herrmann, Harold G. Reineke, and John A. Caldwell. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 353, March 1942.

The authors thoroughly discuss a clinical and roentgenographic entity characterized by (1) prolonged intractible pain in an injured extremity; (2) partial loss of motor function of the affected part; (3) localized vasomotor disturbances in the affected extremity; and (4) spotty demineralization of the bones at the site of the trauma. The importance of differentiating this condition roentgenographically from ordinary atrophy of disuse is stressed. A photograph of a hand, showing the typical oedema, trophic changes, and discoloration of the skin, illustrates one of the cardinal points of the syndrome.

Posttraumatic painful osteoporosis may occur following injury to a joint, with or without fracture. The type and severity of the trauma frequently influences the clinical course of the disease. The aching pain and impaired motor function are greatly out of proportion to the local signs of injury to the tissues. The aching pain cannot be relieved by immobilization, which fact differentiates an advanced case of the disease from tuberculosis or pyogenic arthritis.

A survey of the literature shows that posttraumatic osteoporosis can develop in any bone in the body including the skull. The hands and feet are most frequently affected. The development of the disease may be traced roentgenographically through three stages. At first, there is a general mottled rarefaction of the bones. As the rarefaction continues, the cortex becomes thinned. The cortical thinning may advance to such a degree that the margins of the bones appear poorly defined, and the entire area seems homogeneous. At this stage ankylosis may occur, resulting in permanent disability. During the stage of reconstruction, there is a slow reappearance of calcium in the bones.

The authors urge early diagnosis and active treatment. In their experience, periarterial sympathectomy is the best form of treatment. Forceful manipulation of the joints under anaesthesia is definitely contra-indicated.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

THE ROENTGEN FINDINGS IN INCREASED LEAD ABSORPTION DUE TO RETAINED PROJECTILES. Hyman R. Senturia. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 381, March 1942.

This article contributes two interesting cases of chronic lead poisoning, developing over a period of years from lead bullets lodged in bone. Roentgenograms show the original bullets in the wrist joint and femoral head. Follow-up studies five years later show arthritic changes with flocculent and fragmented deposits of lead in these joints. Symptoms of joint pain, nervousness, headache, dizziness, and sore gums had developed from increased lead absorption. A quantitative chemical analysis of the blood and urine for lead confirmed the diagnosis. After arthroplasty in one patient, with removal of the lead, the symptoms improved, and the abnormal lead levels in the blood and urine returned to normal.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

BONE INFARCTS. S. C. Kahlstrom. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 405, March 1942.

The high incidence of bone infarcts among caisson workers exposed to compressed air is well known. The author stresses the relative frequency of bone infarcts among individuals who have not been exposed to compressed air. The etiology of arteriosclerosis in the production of bone infarcts has been suggested previously by the works of Phemister, Chandler, and others.

The author's five cases of multiple bone infarcts include one caisson worker, three arteriosclerotic individuals, and one patient with neither a history of caisson disease

nor evidence of arteriosclerosis. The roentgenograms illustrate the characteristic well-defined, mottled areas of increased bone density involving the medullary portions of the diaphyses and sometimes extending into the epiphyses. Circinate patterns of calcification are typical. Biopsy material in these cases, however, is lacking.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

POST-TRAUMATIC PARA-ARTICULAR OSSIFICATION OF THE KNEE JOINT (PELLIGRINI-STIEDA'S DISEASE). J. Kulowski. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 392, March 1942.

The author reports eleven additional cases of this disease. The case reports are preceded by a thorough, orderly, and concise description of all phases of the disease. The roentgenographic findings are given in detail.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

ATYPICAL GIANT CELL TUMOR. Bradley L. Coley and Lawson E. Miller. *The American Journal of Roentgenology and Radium Therapy*, XLVII, 541, April 1942.

Distinctly atypical cases of giant-cell tumor are rarely encountered. However, the importance of recognizing them is obvious, for unless their true nature is appreciated, the proper treatment cannot be carried out. The necessity of biopsy in such cases is inferred.

The atypical cases may be divided into two groups: (1) atypical because of clinical and pathological criteria, and (2) atypical because of location.

In the latter group it is essential, of course, to recognize the benign nature of the lesion, so that conservative treatment can be employed. In the former group, the cases are either malignant from the time they are first observed, or they become malignant following unsuccessful treatment. The authors mention several unquestionable examples of malignant transformation in previously benign giant-cell tumors.

Seven case reports with roentgenograms and biopsy material are presented. It is interesting that roentgenographically the malignant cases all showed osteoclasis with cortical and periosteal involvement. An exception to this is a case with Codman's epiphyseal chondromatosis giant-cell tumor of the humerus.—*Richard C. Batt, M.D., Berlin, New Hampshire.*

WAR WOUNDS. John J. Moorhead. *The American Journal of Surgery*, LVI, 338, May 1942.

The author, recently returned from Pearl Harbor and its war casualties, again stresses his former teachings, and adds his clear suggestions to aid all surgeons in the better care of present-day war casualties.

The three essentials of trauma are shock, hemorrhage, and infection. The first two can be handled by external heat, fluids, and whole blood, or liquid or dried plasma.

The basic elements of wound treatment are:

1. Time,—within six hours after trauma;
2. Cleanliness,—washing the parts with soap and water;
3. Débridement,—removing all damaged tissue until three criteria are attained:
   a. The parts look healthy,
   b. Bleeding is present at the excised edges,
   c. The muscle contracts;
4. A dry wound;
5. Sterilization,—the use of a sulfonamide, preferably sulfanilamide;
6. Sutures,—primosecondary sutures or none at all;
7. Dressings,—heavy gauze and cotton applications, plus splinting if there are nearby joints, and elevation and tilting to promote drainage;
8. After-care,—a sulfonamide by mouth and redressings after three days.

Most cases of wound infection are due to combined staphylococcus-streptococcus organisms, and less frequently, to gas gangrene and tetanus. For the usual case manifesting pus secretion and cellulitis, the treatment consists in:

1. Providing an exit for the retained secretions by removal of sutures if present;
2. Applying wet dressings of 3-per-cent. sulfanilamide in water, and keeping them moist by tubes from a reservoir, and hot by electric bulbs.
3. Incision under certain circumstances when localization occurs. Incision is indicated only when local fluctuation, local induration, and local pain exist. It is not indicated for brawny induration, redness, red streaks, or adenitis.
4. A sulfonamide by mouth.

Gas gangrene was treated by liberal débridement, repeated exposure to x-ray, and sulfanilamide in the wound and by mouth. Tetanus was treated by serum, supplemented by sulfanilamide locally and orally.

Pencillin and gramicidin are mentioned as possible new aids in the future, in combating infection in wounds.—*Custis Lee Hall, M.D., Washington, D. C.*

FRACTURES SUSTAINED IN WAR. William Darrach. *The American Journal of Surgery*, LVI, 341, May 1942.

The author stresses the fact that compound fractures form a large percentage of war wounds, and that these war wounds are more complicated, from the standpoint of pathology, than are most civilian injuries, although the principles of treatment remain the same,—first-aid protection of the wounds, early splinting, the use of drugs and the operative cleansing of the wound at the earliest possible moment, reduction of the fragments, and proper immobilization. He also stresses the fact that even though the wounds are débrided early and properly, the consensus is that they should be left open, rather than closed primarily. He also brings out the fact that tension within the wound favors bacterial growth. He considers the order of efficiency of methods of immobilization to be rigid internal fixation by plates or screws, wire or pin traction incorporated into the plaster or external appliance, circular casts alone, and traction suspension.—*Custis Lee Hall, M.D., Washington, D. C.*

THE POTENTIATION OF THE SULFONAMIDES IN THE LOCAL THERAPY OF WOUNDS AND SURGICAL INFECTIONS BY THE USE OF OXIDANTS. Harold A. Goldberger. *The American Journal of Surgery*, LVI, 353, May 1942.

The author reviews the literature in reference to the local use of the sulfonamides, and then discusses the results of laboratory experimentation and clinical experience with 384 patients having various types of infection.

The comparatively low *in vitro* activity of the sulfonamides, when compared with many germicides and antiseptics of surgical practice, suggested their use combined simultaneously with the ordinarily accepted antiseptic agents. Approximately 100 sulfonamide-plus-antiseptic mixtures were employed, and the clinical results showed a clear-cut differentiation between preparations which gave the more or less anticipated results and those which exhibited a potency not easily explained on the basis of a purely additive effect. Oxidizing substances were the most effective agents in almost every instance, and exerted their effects even in concentrations far below the antibacterial levels of the substances if used alone.

The mode of action of the sulfonamides is a direct attack upon the bacterial cells. Potentiated sulfonamides are antibiotic for certain other unicellular organisms and fungi as well as being antibacterial.

The author concludes that sulfanilamide and sulfathiazole used together are more effective than either one used alone, and that they are made much more potent by the addition of an oxidizing agent. Local applications are effective in the form of solutions for irrigation, wet dressings, powders, ointments, pastes, suspensions, and medicated gauze, depending upon the anatomical and pathological characteristics of the lesions.

The most effective oxidizing substances are: in powder form zinc peroxide; in ointments and pastes, azochloramid and zinc peroxide; in solution, iodine, azochloramid, and potassium permanganate.

Wound healing is not appreciably inhibited by the presence of these drugs which, as demonstrated by serum studies, are absorbed from the wounds into the general circulation. Only three instances of idiosyncrasy to local use were encountered.

The author suggests that if every combatant on the field of battle carried potentiated sulfonamide powder for immediate use, a sharp decline in gas gangrene, amputations, and complications subsequent to suppuration could be anticipated.—*Custis Lee Hall, M.D., Washington, D. C.*

Dystrophia Myotonica in Infants and Children. Otto Maas. *The British Journal of Children's Diseases*, XXXVIII, 59, 1941.

Dystrophia myotonica (atrophica) is an endogenous hereditary disease of the nervous system, usually affecting many persons of different generations in the same family. It is characterized by muscle weakness, wasting, and cataracts. The author believes that the condition is found in children and that it should not be distinguished from Thomsen's disease where wasting and cataracts are not found. He has found Thomsen's disease among the children of fathers suffering from dystrophia myotonica. Some show only slight wasting of the temporal muscles, stiffness of the hand, or mental retardation; some find their way to reform school or prison. Later in life the muscle weakness and atrophy become more evident, and cataracts, baldness, and rigidity of muscles impeding active movements—stiff fingers for instance—develop. These patients differ from true spastics in that they can carry out certain movements normally, after having made the same movements several times in succession. There is also a passive excitation of muscles,—that is, if the thenar muscles, for example, are percussed the muscles contract quite slowly and the thumb is held in opposition position for several seconds.

The author illustrates his article with several case histories. The children need special guidance. No cure has as yet been discovered.—*R. T. Boyd, M.D., Iowa City, Iowa.*

Spondylolisthesis Affecting the Fourth Lumbar Vertebra. William MacL. E. Topping. *British Journal of Radiology*, XIV, 162, 1941.

Two cases of spondylolisthesis affecting the fourth lumbar vertebra are reported, occurring in middle-aged laborers who complained of pain in the back. There was no history of definite antecedent trauma in either case. The displacements were estimated to be one-third of an inch. Roentgenographic examination demonstrated the underlying pathological anatomy to be similar to that which is known to be present in the much more common site of spondylolisthesis,—namely, the fifth lumbar vertebra.—*J. E. Fuchs, M.D., Iowa City, Iowa.*

Spontaneous Fracture of the Apparently Normal Neck of the Femur. Kenneth S. Mullard. *British Journal of Surgery*, XXIX, 241, 1941.

In a healthy man of twenty-seven, while undergoing very vigorous army training, involving long hikes and runs, severe pain and disability developed in his femur. A roentgenogram showed a linear fracture, without displacement, one-half inch proximal to the intertrochanteric line. With conservative treatment, healing occurred in seven weeks, with a minimum amount of callus formation.

The resemblance of this "spontaneous" fracture to march fractures is noted in that: (1) there was no history of injury, (2) there was a definite history of repeated severe physical strain, (3) there was gradual increase in disability, but quick relief from rest, and (4) the texture of the bone as seen in roentgenograms was normal.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

AN UNUSUAL CASE OF LOOSE BODY IN THE ELBOW-JOINT. N. Vere-Hodge. *British Journal of Surgery*, XXIX, 274, 1941.

A man, thirty-five years of age, who had sustained a fracture of both bones of the forearm twenty years before, complained of locking in his elbow joint. Roentgenograms showed a loose body in the elbow joint, with a cavity in the olecranon fossa into which the body was thrust on extension. The loose body was removed and proved to be hyaline cartilage with a covering of calcified material.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE SKELETAL AND OTHER CHANGES FOUND IN A CASE OF SUPRASELLAR CYST OF RATHKE'S POUCH. R. A. Rowlands and S. L. Simpson. With a Pathological Report by Dorothy S. Russell and H. M. Turnbull. *British Journal of Surgery*, XXIX, 304, 1942.

This is a case report of a man of forty-three years with a mental and physical development of a boy of twelve. No secondary sex development had occurred. One year before admission to the hospital, he began to have severe headaches several times a week, instead of occasionally as he had had during the previous twenty years. He had momentary attacks of unconsciousness and slept a great deal of the time.

The bone changes are described as follows: "The sella turcica is shallow and the dorsum sellæ is eroded from above downwards; . . . [it] suggest[s] the presence of a calcified suprasellar cyst. The bones of the forearm are very small and thin, and show osteoporosis, but there is no abnormality of texture. The epiphyses of radius and ulna (lower end) remain ununited with the shaft. All the bones of the hand are small, and all epiphyses are ununited. There is no pelvic deformity. The head of both femora are united but 'mushroomed'; the head of the left femur shows a peculiar cystic appearance; there is a loose body in the region of the right acetabulum. The epiphyses of the knee-joints are ununited." Later examination showed disorganization of the hips, with osteo-arthritic changes, eburnation and flattening of the heads of the femora, and numerous large osteophytic bodies.

At autopsy, a suprasellar cyst of Rathke's pouch was demonstrated.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

MONTEGGIA FRACTURES. Arthur Naylor. *British Journal of Surgery*, XXIX, 323, 1942.

Monteggia, in 1914, described two cases of fracture of the upper third of the ulna, with dislocation of the head of the radius. Since then his name has been attached to this type of fracture.

The usual site of this fracture of the ulna is three or four inches below the tip of the olecranon process, and an anterior dislocation of the head of the radius is associated with it. It is usually caused by direct violence applied to the ulna. Continued pressure tends to force the fragments of the ulna apart; the force is transmitted through the interosseous membrane to the radius, with rupture of the orbicular ligament and dislocation of the radial head, either anteriorly or laterally.

For treatment, the author disagrees with the methods of "transatlantic workers" that open operation should be done. He believes that the radial dislocation should be recognized early and reduced by closed methods.

The results in nine cases are not fully stated. He states that in three cases extension was limited to 130 to 160 degrees. In four cases there was complete restoration of function, and in one pronation was limited. Open operation was attempted in one case two weeks after injury, but the ultimate result showed limitation in pronation and extension.

This series is small and includes several children. Two of the dislocations of the radial head were lateral and one was posterior. Three fractures were compound. No real conclusions can be drawn.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

THE TREATMENT OF NEUROGENIC URINARY INCONTINENCE WITH TRASENTIN. Irving Simons. *Bulletin of the Hospital for Joint Diseases*, III, 26, 1942.

Simons notes that after injuries to the brain or cord, with various types of compression, and after neoplasms, systemic disease, and vertebral injuries, dystonia of the bladder may result. Briefly, the neurogenic dystonias of the bladder may be divided into the hypotonic and hypertonic types. The hypotonic bladder is characterized by hyposensitivity, large bladder capacity, a residual urine, and pseudo-incontinence.

The hypertonic bladders are hypersensitive, of small capacity, and present true incontinence. They are usually to be attributed to interference with the fibers of the pyramidal tract, which carry the inhibitory impulses to the parasympathetic centers in the conus. The differentiation between these two types is readily made by means of cystometric and sphincterometric studies.

In the hypertonic type of neurogenic bladder, depressant therapy is indicated. To avoid the undesirable effects of atropin, the author has used trasentin,—a synthetic proprietary drug which is believed to depress the effector endings of the parasympathetic nerves. It has been given clinically in divided daily doses of 600 milligrams which are increased to as much as 900 milligrams at times. In a series of cases to be reported later, the author observed complete relief of incontinence in 50 per cent., and improvement in 20 per cent. of his cases.

These patients were followed for a period of six months following withdrawal of the drug, without recurrence of the symptoms. A typical case in which incontinence developed following laminectomy is reported.—*Henry Milch, M.D., New York, N. Y.*

THE KENNY TREATMENT OF INFANTILE PARALYSIS DURING THE ACUTE STAGE. Philip Lewin. *Illinois Medical Journal*, LXXXI, 281, April 1942.

In this article, Dr. Lewin gives a clear and accurate analysis of the Kenny method of treatment, to which he has given study and personal observation in different clinics in which it has been used. He states the principles and the method of application of the treatment, the technique of which he discusses in detail, and makes a fair and unprejudiced estimate of the results obtained. He discusses and interprets the theory of Miss Kenny's method, which is aimed at: the abolition of muscle spasm, the substitution of mental "awareness" for the pathological "alienation", and the restoration of coordination of muscle activity, and includes:

1. Proper bed placement,—natural rest position.
2. A foot board to preserve the "standing reflex".
3. Hot fomentations to relieve pain and muscle spasm.
4. Special analysis, classification, and reeducation of muscles.
5. Passive movements.
6. Concentration of active movements on the insertions of muscles and tendons.
7. The abandonment of all splints, respirators, and artificial feeding.

Dr. Lewin's discussion of the theory of muscle spasm, rather than paralysis, is particularly helpful. He expresses a very favorable opinion of the Kenny treatment, as shown by her results, and in his summary he states that it is one of the outstanding advances in orthopaedic surgery.

COMPRESSION OF BRACHIAL PLEXUS: THE SCALENUS ANTICUS SYNDROME. Frederick Leet Reichert. *The Journal of the American Medical Association*, CXVIII, 294, January 24, 1942.

In this article the author reports the relief of symptoms of compression of the brachial plexus by non-surgical means in sixty of seventy-four patients. In the past much attention has been paid to surgical relief of symptoms by removing cervical ribs, and by section of the scalenus anterior as popularized by Ochsner, Gage, and De Bakey. Little has been written of the non-surgical method of relief described by Theis in 1939

and Stopfort in 1919, but the results obtained by the author equalled, and in some instances surpassed, those reported with use of the surgical method.

The symptoms of brachial compression due to displacement are the same as those produced by compression over a cervical rib. Compression of the brachial plexus sets up a vicious cycle produced by the constant friction of the plexus. There is an irritation of the branch supplying the scalenus anterior which causes spasm of the muscle, in turn causing the raising of the first rib. This increases the sharp angle between the scalenus anterior and the first rib, producing further compression of the plexus and subclavian artery. The symptoms include pain, numbness, tingling, hyperaesthesias, and paraesthesias anywhere in the distribution of the involved nerves, particularly in the distribution of the nerves from the medial cord which is most affected. There may be cyanosis, coldness, and sometimes gangrene, due to decreased blood resulting from compression of the subclavian artery. All symptoms are aggravated by anything which tends to increase or maintain tension of the scalenus anterior.

The author, in treating the syndrome, used surgical and non-surgical methods. In fourteen patients, section of the muscle was done. Ten of these received complete relief; two had to be reoperated upon; one obtained relief only after procaine injections, and one died of hemorrhage. Good relief of symptoms was obtained in sixty patients by the use of non-surgical conservative methods. These measures included:

1. Elevation of the shoulder by means of a sling.

2. Elimination of work which puts tension on the scalenus anterior and aggravates symptoms.

3. Change and correction of sleeping habits. Over two-thirds of these patients complained of pain more severe at night. It was found that many of these slept with no pillow or only one. By arrangement of pillows in such a way as to get maximum relaxation of the muscle and to overcome the squeezing mechanism, good relief was obtained. Three pillows were arranged in a sort of V, so that when the patient is on his back, his head and neck are thrown forward; and when on his side, the affected shoulder, as well as the head, is elevated by a pillow. When the painful side is up, a pillow should be placed between the arm and the body, or the patient should sleep with the arm above the head.—*Sidney L. Stovall, M.D., Dallas, Texas.*

NECK PAIN. THE LAMINOGRAPH AS AN AID TO THE DIAGNOSIS OF ATLANTO-OCCIPITAL LESIONS. Frederick A. Jostes. *The Journal of the American Medical Association*, CXVIII, 353, January 31, 1942.

The author reviews the neck symptoms, of which no diagnostic procedure revealed the true pathology, even though they respond to treatment. With the advent of the laminogram, a new field of pathological possibilities has been opened up by discarding the overlying maxilla and presenting only the plane of the occipital condyle. Following careful study of the normal relationship of the anatomy of the atlanto-occipital region, the laminograms can be accurately interpreted and the lesion diagnosed.

The author presents several cases to show the true benefit of the laminogram.

Treatment consists in head traction, which the patient can carry out at home, supplemented by heat and other types of support as indicated.—*D. K. Barnes, M.D., Dallas, Texas.*

TREATMENT OF ARTHRITIC JOINTS. Robert J. Joplin and George J. Baer. *The Journal of the American Medical Association*, CXVIII, 937, March 21, 1942

The authors describe and illustrate orthopaedic measures to prevent deformities during the treatment of rheumatoid arthritis. They have reviewed and summarized the apparatus in use by the Boston orthopaedic group, and have added modifications of their own. Special attention is given to the prevention of deformities of the shoulder, elbow, wrist, hand, spine, hips, knees, and feet.

The article is illustrated with photographs to show pulley-exercising apparatus for

the shoulders; cock-up splints for the wrists; banjo splints for the fingers; corsets; head traction; ambulatory hip spicas; bivalved plasters, caliper splints, and cylinder casts for the knees; and foot supports.

This is an excellent article to point out simple apparatus which may be used by general practitioners to prevent deformities in patients with progressive rheumatoid arthritis.—*H. C. Coggeshall, M.D., Dallas, Texas.*

INTRASPINAL OPERATIONS IN COMPENSATION CASES. Arthur Ecker. *The Journal of the American Medical Association*, CXIX, 128, May 9, 1942.

Pneumograms of the spine were made in fifty cases and thirty-eight patients were operated upon, twelve of whom claimed compensable disability. The ages of the patients ranged between twenty and fifty-three years; the preoperative duration of the symptoms was from three months to fourteen years; twelve different occupations were represented.

Cases of prolonged sciatic pain are due to mechanical irritation of the nerve roots, and diagnosis of intraspinal pressure on the nerve roots was made on the history and physical examination. The usual case gave a history of onset while bending forward or straining, early development of backache, later development of sciatic pain, limp on the affected side, increase of pain on coughing or sneezing, relief of pain with bed rest, painful and limited straight-leg raising, limitation of flexion of the lumbar spine, list of the back, paraesthesia especially in the fifth and first sacral dermatome, diminished or absent ankle jerk, tenderness over the sciatic nerve, elevated protein of spinal fluid, and localized tenderness at the site of the lesion. Clinical diagnosis takes precedence over a normal pneumogram. In all patients operated upon, laminectomy of the fifth lumbar vertebra was performed. In addition the thickened ligamentum flavum or the protrusion of the intervertebral disc, or both, were removed. No corset or back brace was prescribed postoperatively. Patients were kept in bed ten days, and in the hospital twenty-one days. They were able to return to part-time light work in sixty days, and to their usual work in four months. Every patient apparently was promptly and permanently relieved of severe pain.—*John K. Coker, M.D., Dallas, Texas.*

THE SCALENUS ANTICUS SYNDROME. Bernard D. Judovich and William Bates. *The Journal of the International College of Surgeons*, V, 26, January–February, 1942.

Calling attention to the syndrome of pain in the shoulder, arm, and hand described by Naffziger and attributed by him to a tightened scalenus anterior, the authors elaborate on the etiological mechanism. They believe that an occasional anomaly of the muscle is encountered in which a slip of the muscle passes behind the subclavian artery, and that hypertrophy of the muscle causes pressure on the subclavian artery, the brachial plexus, and the cervical sympathetic nerves either directly or through elevation of the first rib. In spite of this localized pressure mechanism, that should involve only roots from the fourth cervical to the second thoracic at the most, their case reports indicate the coexistence of pain in the cervical plexus and in thoracic roots as low as the fifth thoracic, but no explanation is offered to show how the taut scalenus anterior can produce the pain. The treatments used by them were:

1. Procainization of the muscle by a technique that is carefully described.
2. Cutting of the scalenus anterior.

They indicate that the procaine injection is at times productive of an undesirable complication,—a Horner's syndrome.—*I. William Nachlas, M.D., Baltimore, Maryland.*

OBSERVATIONS AND PROBLEMS ON OPERATION FOR LESIONS OF THE SEMILUNAR CARTILAGE. Felix Mandl. *The Journal of the International College of Surgeons*, V, 63, January–February, 1942.

The observations are based on 840 cases of pathology of the semilunar cartilage treated by the author by operation. It is noted that the incidence of ruptured menisci

is greater now, chiefly because of the increase in sports and "particular-position" occupations. A major trauma is not essential to the production of a rupture. Pathological fractures can take place in cartilages which have undergone degenerative changes. Tearing of the cartilage is more prevalent in medial menisci, while cysts are more frequently found in the lateral ones. This may in part be due to the fact that in the newborn the outer meniscus still consists of hyaline cartilage. In the determination of which cartilage is torn, the author finds Bragard's sign of great value. Roentgenograms have been helpful in older patients, when calcification has taken place. Though he does not operate when the injury is acute, chiefly because he feels that an accurate diagnosis cannot be made at that time, he considers arthrotomy the only rational treatment when the rupture is recognized. Though regeneration of the removed cartilage can take place, the "regenerate" is of connective tissue. The operations are performed without a tourniquet and under local anaesthesia. To reduce the postoperative effusion, a window is cut in the suprapatellar pouch. Immobilization is made by a posterior splint, and early movement is encouraged. He reports "lasting good results" in 95 per cent. of his cases.—*I. William Nachlas, M.D., Baltimore, Maryland.*

THE TREATMENT OF FRACTURES OF THE FEMORAL NECK IN THE AGED. Herman de Las Casas. *The Journal of the International College of Surgeons*, V, 98, March–April, 1942.

In a study of the end results following internal fixation of fractures of the neck of the femur, the author is impressed by the large number of "failures". The greatest difficulty, granted that satisfactory reduction has been accomplished, lies in the fact that a necrosis of the head of the femur takes place. In some instances there is a gradual shortening of the neck of the femur.

A careful study of the circulation of the upper end of the femur was made, and revealed the fact that, in the aged, the blood vessels are inadequate to supply the nutritional needs for healing of the broken bone. The distribution of the vessels is such that fractures of the neck break the line of food supply, so that an aseptic necrosis takes place. This is particularly true in subcapital fractures. The author, therefore, feels that in most instances of subcapital fractures, an operation designed to remove the head is preferable. In the other cases, he prefers autogenous grafts as his method of internal fixation. Above all, he stresses the fact that it is necessary to individualize the patient. The article contains a great deal of valuable information and is worth reading in detail.—*I. William Nachlas, M.D., Baltimore, Maryland.*

TRAUMATIC CONDITIONS OF THE WRIST. F. G. Hodgson. *The Journal of the Medical Association of Georgia*, XXXI, 66, February 1942.

Three of the more common disabilities of the wrist are described, and their appropriate treatment is given. For Colles' fracture, after accurate reduction, a non-padded plaster-of-Paris splint is applied; is held in place by a three-inch bandage; and extends from the metacarpophalangeal joint to the elbow. This should be worn for five weeks without interruption, and the use of the hand and fingers should be encouraged from the very beginning. If the fingers are properly used and exercised, very little stiffness or disability will be present when the splint is removed.

Fracture of the carpal scaphoid is discussed. With prolonged immobilization of the hand in plaster, which does not prevent use of the fingers, union practically always occurs, and operation is not necessary.

Dislocation of the carpal navicular should be reduced early by manipulation. If seen late, operative removal of this bone is advised.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

VITAMIN B_6 (PYRIDOXINE HYDROCHLORIDE) IN THE TREATMENT OF PSEUDOHYPERTROPHIC MUSCULAR DYSTROPHY AMONG CHILDREN. Haddow M. Keith. *The Journal of Pediatrics*, XX, 200, 1942.

The author treated ten boys with vitamin B_6. The five oldest (ten to twelve years)

were unable to walk or stand; two (seven and nine years) walked with marked lordosis and typical waddling gait; and the three youngest (three years and nine months to five years) were able to walk without much assistance.

With a simple apparatus of rope, weights, pulley, and arm and foot rests, the strength of the pectoral and gluteal muscles was tested in all but two patients. One of these was too young to give good cooperation, and the other was too weak to operate the apparatus.

Contrary to the experience of others, the author found that the intramuscular injection of vitamin B_6 in amounts of 100 to 200 milligrams weekly for two to eight months, did not produce any measurable improvement in the strength of the pectoral and gluteal muscles, or any increase in general muscle strength which could be noted.

Vitamin B_6 in these amounts did not have any deleterious effect either general or local.

A Case of Leprosy with Charcot's Joint. R. Subramaniam. *Journal of South Indian Medicine*, VII, 134, 1941.

The author reports an unusual case of leprosy, under treatment for seven years, in which the outstanding feature was a Charcot joint of the left ankle and foot. Roentgenograms showed rarefaction and absorption, particularly of the navicular and the fourth metatarsal. The author discusses the differential diagnosis between leprosy, syringomyelia, and tabes dorsalis.

The treatment advised was conservative: glycerine magnesium sulphate packs to the affected leg, and continued use of chaulmoogra oil.—*Robert M. Green, M.D., Boston, Massachusetts.*

On Calvé's Disease (So-Called Flat Vertebra). L. L. Lutrovnik. *Khirurgiya*, V, 85, 1941.

The author gives a description of the pathology and the phases of the disease. A history of an early occurrence of the disease in a patient seventeen months old is presented, followed by an observation of the clinical and roentgenographic development until recovery. At the age of two years and nine months, the patient showed complete clinical recovery and a marked regeneration of the vertebral body. However, the complete height of the vertebral body was not restored. In his conclusions, the author states that Calvé's disease is not rare and may be observed at a very early age. It is a disturbance of the normal growth of the vertebra, and in the earlier stage, about the fourth to the sixth week after the onset, it has the roentgenographic and clinical appearance of acute tuberculous spondylitis. The treatment should be conservative, persistent, and long. Full weight-bearing should not be permitted until definite signs of recovery are evident.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

The Genesis of Rachitic Exostoses of the Tibia. Z. A. Landress. *Khirurgiya*, V, 90, 1941.

The author made an anatomical and clinical study of the etiology of rachitic exostoses in the tibia. Personal observations indicated that these exostoses are observed only in patients in whom genu valgum is accompanied by a valgus curvature of the tibia. The author further noticed that, in the cases of genu valgum, where the inclination of the articular line only was changed, no exostoses were observed. Histologically, the exostoses are metaplastic ossifications of the tendon of the flexor digitorum longus, with subsequent osteoblastic bone formation in the insertion areas. They are produced by the constant stretching of the medial collateral ligament and the flexor digitorum longus. The presence of pes planus further increases the pull of the flexor digitorum longus and produces a flexion deformity of the toes and an adduction of the forefoot.—*Emanuel B. Kaplan, M.D., New York, N. Y.*

THE SALVAGING OF FRACTURE OF THE FEMORAL NECK. Royal Whitman. *The Lancet*, I, 378, March 28, 1942.

In this article, Dr. Whitman presents clearly and accurately the development of the treatment of fracture of the neck of the femur from the time when it was considered beyond the limit of successful surgery. It is evident to those who have had the opportunity of observing the gradual change in treatment, that the improvement began with Dr. Whitman's method of employing the abduction principle. He made use of an entirely new mechanical principle, and brought about the recognition of the value of the abduction method. Practically all of the methods since devised, which have contributed to the development of the treatment of this injury, have been based on the fundamental principle of the use and the mechanics of the abduction position. Even the use of the graft, and the later methods of metal fixation, bring in this principle, but with internal, rather than external, means for its accomplishment.

The review of the treatment for this fracture is given very clearly and interestingly in this article, and its presentation is timely. The history of its development should not be lost at this time when the treatment is becoming so much more definitely successful, and it would be well for the younger generation to be familiar with the rather remarkable development of the treatment of this difficult problem which was begun at the time when the x-ray was not available to give that aid without which the successful application of the methods today would not be possible.

PREVENTION OF HAMMER-TOE BURSITIS. Kenneth McFadyean. *The Lancet*, I, 474, April 18, 1942.

The author points out that, in the hammer-toe deformity, most of the pain arises from attacks of acute bursitis in the small bursa which early develops over the head of the first phalanx as a result of friction between the toe and the shoe. He outlines a treatment which consists of a well-fitting shoe of standard type and a stock wooden tree which accurately fits the selected shoe. Usually this can be secured without going to the expense of having a tree made. A small metal dome should then be attached to the tree at the site of the toe deformity and every new shoe should be stretched by this tree, first by itself, and then for a further period with a thin sock and later with two thin socks covering the tree. The author recommends purchasing shoes three months before they are to be worn.—*Lenox D. Baker, M.D., Durham, North Carolina.*

TREATMENT OF INTRACAPSULAR FRACTURES OF THE FEMORAL NECK. A. S. Blundell Bankart. *The Lancet*, I, 250, February 28, 1942.

The author does not present a series of cases, but indicates some points which seem to call for further consideration if the Smith-Petersen nail or similar devices are to be placed on a surer basis. In discussing the selection of cases, the author points out several feasible contra-indications for nailing, and in some instances he feels that it is better to do a transtrochanteric osteotomy at once, rather than to wait for the failure of a nailing operation. He recalls that the impacted subcapital abduction fracture always heals with bony union if it is treated in a short walking plaster spica, and he suggests that weight-bearing on an impacted fracture is not in itself harmful, so long as the joint is not moved, and he considers whether this has any bearing on the treatment of adduction fractures after internal fixation. He questions whether, in fact, the nailed adduction fracture should not be treated in the same way as the impacted abduction fracture,—in a short walking plaster spica. When cases unsuitable for nailing have been eliminated, the principal causes of failure are: imperfect reduction of the fracture, faulty application of the nail, and inappropriate after-care. In reducing the fracture, he feels that well-leg counter traction is the best method, as this can be adjusted at leisure, and when the reduction is perfect the patient can be lifted safely on the operating table with the traction still on the limb. In inserting the nail, he points out that the more vertically

the nail is placed, the less will be the breaking strain across it, and the more will the proximal fragment be guided towards and pressed against the distal fragment by pressure from above, and he states that the best angle for the nailing is one of 140 degrees with the long axis of the shaft of the femur. He points out that a nail can hold fragments apart as well as hold them together. He feels that the common practice of forbidding weight-bearing for some months after the operation while encouraging active movement of the hip should be reconsidered, and he gives reasons for believing that early weight-bearing should be encouraged while movement of the hip should be prevented until bony union has taken place. He outlines his technique for the nailing operation, and points out the importance of anchoring the proximal fragment to the pelvis while the nail is being driven in, in order to avoid displacement of the head by the oncoming nail. The article is most timely and contains many excellent suggestions.—*Lenox D. Baker, M.D., Durham, North Carolina.*

Disuse Atrophy of Skeletal Muscle. J. C. Eccles. *The Medical Journal of Australia*, II, 160, 1941.

This paper describes preliminary investigations into the physiology of muscles suffering from disuse atrophy, and is also an attempt to discover the daily dosage of stimulation required to prevent the atrophy. This latter study has clinical significance in relation to the prevention of the disuse atrophy which occurs during immobilization when limbs are in plaster casings or when patients are kept in bed for long periods.

In twenty cats, muscles of the hind limbs were made completely inactive for several weeks by section of the spinal cord in the upper lumbar region and of all the dorsal roots below this level. The innervation of the muscle remained normal, but it atrophied because of disuse. The moist and dry weights of the muscles investigated fell to about 60 per cent. of normal in three weeks. The tetanic contraction strength fell still further.

An attempt was made to prevent disuse atrophy by tetanizing the motor nerve for different periods daily in different experiments, this artificial exercise being made as nearly normal as possible. It was surprising to find that all daily periods of tetanization, from ten seconds to two hours, had a similar effect. The greatest benefit was noted in the tibialis anterior and in the extensor digitorum longus. The gastrocnemius and the soleus showed the least change from the stimulation.

It is concluded from these experiments that the usual periods of stimulation in electrotherapeutic practice are much too long. Attention should be directed toward only a few minutes of stimulation daily, and to additional passive and active motions.—*H. M. Childress, M.D., Charleston, South Carolina.*

A Comparison of the Effects of Disuse and Denervation upon Skeletal Muscle. G. Reid. *The Medical Journal of Australia*, II, 165, 1941.

It has long been shown that mammalian skeletal muscle undergoes definite morphological changes following division of its nerve supply. The problem is whether the atrophic changes in muscle consequent to denervation are due simply to disuse, or whether they are to be explained in terms of the lack of some influence, other than motor impulses, of the anterior horn cell on the muscle fibers which it supplies. It has been suggested that such a trophic influence might be comparable with that which exists between a nerve cell and its processes, and which is concerned with the integrity of the whole cell as a living unit. Experimental disuse of muscle has been brought about by tenotomy and by immobilizatic. of such muscles in plaster casings. In such cases, however, the nervous system has been left in intact.

Lumbar laminectomies were performed on cats with the cord being divided above the fourth lumbar and below the second sacral segments. The intervening dorsal roots were divided on both sides, but the ventral roots were only divided on one side. Both hind limbs were then encased in plaster. Experiments were made on the affected muscles at varying periods.

Conclusions were that morphological changes in skeletal muscle five to six weeks following denervation are not entirely due to disuse. The nuclear changes in the tissues on the denervated side were markedly increased as compared to such changes on the disused side.—*H. M. Childress, M.D., Charleston, South Carolina.*

CAUSATION OF FRACTURES OF THE NECK OF THE FEMUR. E. Sandner and E. C. Thompson. *The Medical Journal of Australia*, II, 383, 1941.

The mechanism of causation of fractures of the neck of the femur has never been satisfactorily explained. Fractures resulting from a fall have a definite traumatic factor to explain their occurrence; but in the case of those occurring from a trip or a false step, the traumatic factor is not so obvious. It appears that the solution of this problem lies in the understanding of the mechanics of the hip joint, together with the spring or shock-absorbing mechanism of the leg.

The author explains the spring action of the muscles and arches of the feet, and shows how such protection is aided by the muscles of the knee and the hip. In brief, in well-nourished individuals under ordinary circumstances, the femoral neck is well protected. The situation is not the same when a waddling elderly lady trips. When the posterior foot is moved forward it becomes caught in some object. The body weight continues to move forward while the victim attempts to extricate the foot by elevating it. Once the foot is released it is moved forward to prevent a fall. The knee is in extension and the pelvis on the same side is elevated with the thigh adducted. No shock-absorbing mechanism can work as the body is brought to a sudden stop, and a force of great magnitude is suddenly applied to the head of the femur. It is not unusual for elderly people to sustain such fractures without accompanying falls.

In order to check their estimations as to the cause of femoral fractures, the authors constructed models of the pelvis and hips made of five-ply timber. The results agreed with the theoretical values within 5 to 10 per cent. From the results, when any angularity of muscle action is taken into account, the vertical force at the head of the femur is approximately two and one-half times the weight of the trunk plus one leg.

The collection of clinical evidence is too meager and the number of cases too small, according to the writers, for the actual case records to be of value.—*H. M. Childress, M.D., Charleston, South Carolina.*

COMPOUND FRACTURES. Harry C. Blair. *Northwest Medicine*, XLI, 23, January 1942.

The author advocates four principles in handling compound fractures.

1. Débridement, in which the tissues with a diminished blood supply are removed with a sharp knife or scissors. No antiseptic is placed in the wound, but, if dirt is present, it may be washed with green soap for fifteen minutes. Great care should be exercised to avoid trauma to the tissues. No sutures are placed within the wound. Sulfanilamide or sulfathiazole is implanted.
2. The skin is closed.
3. The fracture is reduced, usually by pins which are incorporated in a plaster cast.
4. The wound is exposed by cutting and removing all padding and gauze. A fine-meshed wire netting is placed over the window.

The author places considerable stress on exposure of the wound, and on allowing the extruded serum to form a coagulum over the wound. Ten days or a fortnight should elapse before any correction for deformity is made, and complete rest for the limb should be stressed during this period.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

TUBERCULOSIS OF THE KNEE IN ADULTS. H. J. Wyckoff. *Northwest Medicine*, XLI, 120, April 1942.

The author uses Steinmann pins to fix the joint within the cast after a fusion operation. This rigidly immobilizes the limb and hastens the healing, besides giving greater comfort to the patient.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

SCIATICA FROM ANEURYISM OF SCIATIC ARTERY. John F. LeCocq. *Northwest Medicine*, XLI, 121, April 1942.

The author reports one case of this rare condition. The patient had injured his lower back, in heavy lifting, fifty-three years previously, and had had more or less distress ever since. In July 1941, while picking strawberries, he developed a more severe pain in the lower back, centering in the right buttock. Examination revealed a visual pulsation and audible bruit in the right gluteus maximus. Operation revealed an aneurismal sac the size of a small orange entangling the trunks of the sciatic nerve. It was removed and the results were satisfactory.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

THREE C'S OF SURGICAL HEALING. Edwin A. Nixon. *Northwest Medicine*, XLI, 129, April 1942.

The author's three C's are for vitamin C, cotton thread for sutures, and cellophane. He elucidates the functions of vitamin C in wound healing, and gives the advantages of cotton thread for suture material. He believes it causes less tissue reaction, is better adapted to contaminated tissues, is less likely to cause sinus formation, and shortens healing time. He uses black or white thread numbers thirty to sixty. He uses cellophane to cover the wound, thus making it, at all times, visible for inspection.—*Charles Lyle Hawk. M.D., Los Angeles, California.*

THE USE OF VITALLIUM IN SURGERY WITH SPECIAL REFERENCE TO CUP ARTHROPLASTY. W. H. Cole. *Proceedings of the Royal Society of Medicine*, XXXIV, 779 (Section of Orthopaedics p. 29), 1941.

The author discusses the use of various metals prior to the development of vitallium, and feels that the latter is the most "silent" of all. He describes his findings in two cases in which he was able to examine the femoral heads six months and one month after cup arthroplasty had been done. In the first case the cup split six months after surgery when the patient was up and about with an excellently functioning hip. In the other, where no weight-bearing and very little motion had taken place, the patient died one month postoperatively. No cartilage replacement was noted as contrasted to the findings reported by Smith-Petersen in two patients, twenty-one and twenty-five months postoperatively. In the author's first case the cup had to be pried from the head. However, on removal of the cup, the head was excellently molded, smooth, and glistening, as was the acetabulum. Microscopically the head and acetabulum were lined with fibrous tissue. In the second case, the cup was loose and the stump of the neck (the head had been necrotic and therefore removed) was rounded and smooth, with irregular islands of what appeared to be cartilage but histologically revealed organizing fibrous tissue.

The author feels that removal of the cup two to three years postoperatively might result in a better hip. He also suggests that the cup fit loosely over the neck, so that motion may take place beneath it as well as between it and the acetabulum, in order to better form a new weight-bearing surface.

In postoperative treatment, the author places the extremity in balanced traction immediately following surgery, and a little swinging motion is attempted the very next day. This motion is increased gradually, and after two weeks is assisted by passive swinging, abduction, and adduction. A stationary bicycle is very worth while prior to weight-bearing, which can be started in five to eight weeks, if the bone in the femoral neck is not too cystic or atrophied. The author strongly advises against forcing too much motion at the start. He believes this should develop by continuous exercise and use. He also mentions the fact—and cites several cases—that these arthroplasties are remarkably free of pain on motion, despite previous arthritic involvement of the operated hip.—*S. M. Albert, M.D., Iowa City, Iowa.*

ACHONDROPLASIA FOETALIS (CHONDRODYSTROPHIA FOETALIS). E. L. Jenkinson and R. E. Kinzer. *Radiology*, XXXVII, 581, 1941.

Achondroplasia is defective evolution, in the process of endochondral ossification, evidenced at a very early period of intra-uterine life. The disease often is familial, with preponderance among females. The patients frequently have a large head vertex, pug nose, and blue sclerae. The trunk is of normal length; the extremities thick and short. The hands are broad and the fingers divided into three groups, divergent at the ends, the "trident hand". The adult achondroplastic dwarf is usually under four feet in height. The condition should be distinguished from hereditary deforming chondrodysplasia, the former developing prenatally and often proving fatal, while the latter develops in childhood and seldom affects the span of life. Moreover, achondroplasia affects only the epiphyseal cartilages, while the exostoses of chondrodysplasia arise from the diaphyseal side and extend in the direction of the muscle pull. Microscopically, the cartilage cells in achondroplasia are large, not arranged in rows, and tend to grow in all directions, while in the cartilagenous exostoses their arrangement is orderly.

The cause of achondroplasia is not known. The condition apparently is inherited, and in the mendelian order.

The rare condition described by Morquio as "Chondro-osteo-dystrophy" also produces a dwarfed skeleton, with irregularities of ossification at the metaphyses.

Five new cases of achondroplasia, four of them in negroes, are described and illustrated.—*Edward N. Reed, M.D., Santa Monica, California.*

CALCIFICATION AND OSSIFICATION OF VERTEBRAL LIGAMENTS (SPONDYLITIS OSSIFICANS LIGAMENTOSA): ROENTGEN STUDY OF PATHOGENESIS AND CLINICAL SIGNIFICANCE. Albert Oppenheimer. *Radiology*, XXXVIII, 160, February 1942.

The pathogenesis of this condition is disputable. The longitudinal ligaments are often calcified or ossified in the presence of vertebral infections,—such as tuberculous typhoid, staphylococcic osteitis, syphilis, and malta fever; after trauma; and, less commonly, around malignant metastases. It may be present in juvenile and in senile kyphosis.

Bone hypertrophy always follows rarefaction. When vertebrae adjacent to a thinned disc are constantly injured mechanically, because of the loss of thickness and elasticity of their natural buffer, traumatic rarefaction results,—a reaction corresponding to callus formation. A triangular area between the anterior vertebral edge, the attachment of the longitudinal ligament to the body above this edge, and to the disc below, presents a vertebral surface devoid of ligamentary covering. It is in this space that vertebral osteophytes form. Instead of playing an active part in the formation of osteophytes, the vertebral ligaments mold them and set a limit to their growth.

The longitudinal ligaments may be calcified or ossified in the absence of other vertebral lesions. This tends to occur where the ligament is relaxed, as opposite a reduced intervertebral space or on the concave side of a kyphosis or scoliosis. Calcification and ossification of vertebral ligaments are not typical of any disease, and should not be confused with arthritis. In their presence, vertebral mobility is normal, unless there is also present disease of the apophyseal joints or vertebral bodies. Complete spinal rigidity has been observed in Marie-Strümpell disease, in the entire absence of calcification or ossification of ligaments. This condition does not cause pain. It is not a pathological or a clinical entity, but a secondary reaction, often indicating the coexistence of a lesion of the vertebral bones or joints.—*Edward N. Reed, M.D., Santa Monica, California.*

MARCH FRACTURE. George R. Krause. *Radiology*, XXXVIII, 473, April 1942.

The term is applied to fracture of a metatarsal occurring in persons who have experienced prolonged and repeated foot strain, but have not suffered a single obviously severe injury. The pathogenesis is not clearly understood. These fractures are the

result of repeated subthreshold mechanical insults, acting by summation to a point beyond the capacity of the bone to bear stress. The onset is usually gradual, but may be abrupt. There is discomfort in the metatarsal area, at first slight, but increasing, and manifest only on weight-bearing. Technically perfect roentgenograms, showing maximum detail, and in anteroposterior and oblique projections, are necessary to make an early diagnosis. The fracture line is often difficult to demonstrate, and films made during the first ten days may show no pathological changes. There is no displacement, and the fracture is often incomplete. In from one to three weeks, a fuzzy spindle of callus appears around the shaft of the second or third metatarsal, at which time the fracture line usually becomes visible. In another three to six weeks the callus becomes less bulky and more sharply defined. Several months later the only remaining sign is slight thickening of the cortex.

Differentiation must be made from osteogenic sarcoma and from Ewing's tumor, usually by the history and the roentgenographic changes during the first three weeks. The treatment is by immobilization for three to six weeks, followed by physiotherapy. Ten cases are reported.—*Edward N. Reed, M.D., Santa Monica, California.*

CINEMATIZACIÓN DEL MUÑÓN DE AMPUTACIÓN (Cinematization of Amputation Stump). Francisco Garcia Diaz. *Revista Española de Medicina y Cirugia de Guerra*, IV, 1, 1941.

Work in the field of the cineplastic stump was stimulated by the modern perfection of prostheses. At best, however, a mechanical hand is insensitive, and only one to three motor levers can be used, for humans do not possess individual action of the muscles of the stump. The history of the development of prostheses is given.

Siegel in 1929 studied 539 patients with cineplastic stumps. In 68.7 per cent., a Sauerbruch prosthesis was worn; in 21.3 per cent., no prosthesis was worn, because of discomfort, neuromata in the cineplastic canal, or vague complaints of discomfort or inutility of the appliance; and in 10 per cent., a prosthesis was worn, but the stump was not cinematized. Of the 68.7 per cent. wearing a prosthesis, 68 per cent. estimated their capacity for work at almost 100 per cent., and only 13 per cent. had as little as 50 per cent. use of the arm.

Trendel in 1933 studied thirty cases with a ten-year follow-up. Of the twenty-one cineplastic stumps of the upper arm, nine were good, and twelve poor; of the nine stumps of the lower arm, four were good, and five questionable. He concluded that the formation of a cineplastic stump is the operation of choice for double-arm amputations. In single amputations in a laborer, a "working stump" is probably preferable, but a business or professional man may make good use of a cineplastic stump.

Modern techniques for cineplastic amputations, depending upon the site of the amputation, include:

1. Phalangization of the first metacarpal,
2. Claw procedure used by Krukenberg,
3. Canalization recommended by Sauerbruch and Pellegrini.

The author has had six cases in which he has used some one of these procedures. The results of phalangization of the first metacarpal in two cases were excellent. Krukenberg's pincer, which affords an excellent amputation stump, was used in one case. The rotary type of prosthesis (Delisch) is the most satisfactory. Sauerbruch's canalization was used in three cases,—one in the lower forearm, one in the upper forearm, and the other in the upper arm.

It is a debatable question whether, in forearm amputations of the lower third, cinematization is better than a Krukenberg's stump. The amputation stump is first revised, so that the extensor and flexor tendons are freed from bone and joined to each other over the stump. Six weeks later canalization is done, using both volar and dorsal muscle flaps. These work as antagonists and protagonists, and give strength and refinement to movements of the prosthesis. A rotary type of prosthesis is best.

For upper forearm stumps, two extrasegmental motor levers are fashioned,—one in the biceps and the other in the triceps. The biceps insertion is cut, and a portion of the triceps is freed entirely from the lateral extensors. Elbow movements are entrusted to the brachialis for flexion, and to the lateral extensors for extension. The biceps flap closes the hand, the triceps opens it. If the stump is very short, it may demand fashioning to receive the prosthesis. Long periods of training are required to develop refinement in the control of these flaps.

For amputation in the upper arm, the author used only a biceps flap to close the hand, and a spring to open it. This was his first case, and only one motor element was used, so as to simplify the prosthesis. The elbow was flexed by flexing the stump. Rotation was controlled mechanically by the prosthesis.

The author emphasized that, in time, a patient with an upper-arm prosthesis develops a muscle sense and sight which enables him to "sensitize" the prosthesis.—*Victor Richards, M.D., San Francisco, California.*

EL PIE PLANO POR INSUFICIENCIA EN LOS HERIDOS DE GUERRA (Flat-Foot from Insufficiency after War Wounds). Manuel Cardenas. *Revista Española de Medicina y Cirugia de Guerra*, IV, No. 33, p. 257, 1941.

Flat-foot after war wounds of the foot is seen most commonly under three conditions:

1. After large wounds of the osseous system;
2. In the good leg after amputation of the injured extremity;
3. In both feet after wounds in a single foot.

In all of these groups, the etiology is an excessive load on an arch insufficient from inactivity, atrophy, or nerve or vascular lesions of the extremity. There are four fundamental pathological features of flat-foot:

1. Displacement of the bones of the foot,—abduction of the os calcis, flexion of the talus, dropping of the proximal ends of the metatarsals, cuboid, and cuneiforms, and supination of the forefoot with spreading of the toes;
2. Deformity of the bones,—thinning and erosion at the abnormal points of contact, and exostoses and enlargement where no pressure exists;
3. Articular lesions,—deforming arthritis;
4. Lesions of the soft parts,—stretching and relaxation.

After any injury to the foot, attempts should be made to prevent the initial insufficiency of the arch by giving calcium and vitamin D by mouth, by massage and physiotherapy of the foot, circulatory exercises, and muscle exercises. Foot pads and plates are permissible if used with caution. Once an insufficiency of the arch has occurred, subsequent deformity will ensue, and surgery will then be necessary. The author feels that the Young operation is best for these cases. This operation consists in drilling a hole through the navicular, and rerouting the course of the anterior tibial tendon so that it passes through this tunnel. It serves three distinct purposes:

1. It elevates the internal longitudinal arch;
2. It suppresses the normal fanning action of the tendon on the metatarsal arch;
3. It approximates the plantar surfaces of the mid-tarsal and metatarsotarsal joints, thereby spreading their dorsal surfaces.

Care must be taken in performing the operation to prevent a luxation of the tendon from the navicular tunnel. The author does not like any other soft-tissue operation, and reserves osseous procedures (triple arthrodesis and wedge osteotomy) for late, severe, and intractable cases.—*Victor Richards, M.D., San Francisco, California.*

HERIDAS DE GUERRA DE LA ARTICULACIÓN DE LA RODILLA (War Wounds of the Knee Joint). M. García Portela. *Revista Española de Medicina y Cirugia de Guerra*, IV, No. 29, p. 35, 1941.

The author reports on his experience with twelve cases. Injuries of the knee are the most frequent of all joint injuries, occurring in 1.86 per cent. of all war wounds. Diagnosis of penetration of the knee joint is made if:

1. Entrance and exit wounds obviously involve the joint;
2. Hemarthrosis is present;
3. Synovial membrane protudes from the wound;
4. Normal saline, injected aseptically into the knee joint, runs out of the wound;
5. Roentgenograms disclose an intra-articular bone lesion.

The mortality rate from compound injuries of the knee was 84 per cent. in the Civil War, 10 to 20 per cent. in World War I, and probably less in the Spanish War because of earlier treatment of the injured. If these wounds can be treated within eight to nine hours of injury, open operation, with careful débridement and removal of all foreign bodies should be performed, and the joint immobilized in the position of optimum function. The author describes in detail the early and late treatment of these wounds.

Early treatment, usually under eight to ten hours, is given as follows:

1. For trauma limited to the soft parts, the entrance and exit wounds are excised down to the joint cavity, all clots, bloody discharge, and foreign bodies are removed, and the wound is sutured in layers without drainage. For larger wounds with more extensive tissue damage, the author débrides the wounds of entry and exit, and then does a clean arthrotomy of the knee to remove foreign bodies, bullets, and clots from it. He prefers a clean arthrotomy of the knee to enlarging the wound of entry. The arthrotomy wound is closed *per primam*, as are usually the débrided wounds.

2. Lesions of soft parts and discrete osseous lesions, particularly of the patella, are treated by arthrotomy with débridement of all dead and devitalized tissue. Since extensive comminution of the patella is usually present, suturing the peripatellar tissues with slowly absorbed catgut should be done rather than by encircling the patella with wire. The joint is irrigated with saline, Rivanol or Chlumsky solution. Articular drains are not advised, but small gauze drains may be placed in soft tissues outside of the sutured capsule for forty-eight hours, if infection is suspected. Plaster immobilization with elevation of the limb is strongly recommended.

3. For knee wounds with bone lesions of the femur or tibia, when articular function is undoubtedly lost, primary resection of the joint is indicated. The removal of more than a total of six centimeters of bone is not advised, because an unstable fusion with marked shortening will result. Occasionally a clean fracture of a femoral condyle can be replaced and held with a screw. If vascular and nerve lesions are also present, and conservative treatment seems futile, immediate amputation should be done.

Late treatment, after twenty-four to thirty-six hours, is as follows:

If only the soft parts are involved, or if the joint function may be restored, the injury is treated conservatively and watched carefully for infection. If infection occurs, and is of a benign type (anterior compartment), it may be treated by repeated aspirations, irrigation with saline, Rivanol, or Chlumsky solution, or by simple anterior arthrotomy of the joint. If posterior extension or capsular phlegmon appears, resection of the joint provides the best drainage; it sacrifices the joint, but saves life and limb. After resection, the quadriceps pouch must be completely opened and the joint held acutely flexed to permit adequate drainage. Later the joint is placed in the position of optimum function and is immobilized. Amputation is done as a life-saving procedure.—*Victor Richards, M.D., San Francisco, California.*

CALCIFICACIONES SUBDELTOIDEAS (Subdeltoid Calcifications). Oscar R. Marottoli and Arnoldo Didier. *La Revista de Medicina y Ciencias Afines*, III, 495, 1941.

This paper is based on clinical experience with a number of cases treated during the last few years, in which the pathology was a calcification in the tendon of the supraspinatus. This condition is a part of periarthritis of the shoulder, and is synonymous with subdeltoid calcification. The condition comes on in various ways and the symptoms vary with the pathogenesis. Various theories have been suggested as to the etiology of the disease, and these are discussed, with references to the literature given. The cause is still uncertain although trauma probably plays an important part. The characteristic

roentgenographic findings are given together with the technique for obtaining roentgengrams of the area. The treatment varies with the stage of the condition and the symptoms, so that no universal method of treatment can be used. Radiotherapy is sometimes useful and the technique is outlined. Surgical treatment in the form of exploration of the subdeltoid bursa with removal of the calcified mass from the supraspinatus tendon is frequently done, using the technique described by Carnett. The authors present a series of seven cases of their own in some detail. One patient was treated with heat, and made a complete recovery; one, with novocain injection, and recovered; and two, with roentgenotherapy, but received little or no relief. These two patients were then operated upon for the removal of the calcium deposit, and made a satisfactory recovery.—*Louis W. Breck, M.D., El Paso, Texas.*

SOBRE UN CASO DE OSTEOMIELITIS DE LA DIAFISIS FEMORAL EN APARIENCIA PRIMITIVA (Report of a Case of Typhoid in Which the First Manifestation Was in the Femoral Diaphysis). R. A. Marotta y Fernando M. Bustos. *La Revista de Medicina y Ciencias Afines,* III, 644, 1941.

The authors quote Keen who reported a series of forty-seven cases of typhoid osteomyelitis, ten of which developed in the first two weeks of the disease. More often the osteomyelitis may develop much later in the course of the disease, and the authors mention a case of theirs in which the osseous lesion developed twenty-eight years after the intestinal typhoid. They believe that Furbringer was right in stating that the osseous lesion may precede the intestinal symptoms. It is possible that in these cases the patient may have the so-called ambulant type of typhoid, and it may not be recognized. The authors report a case of their own in great detail.

The patient, a boy of nineteen, had not been feeling well for a period of eight days before the infected area was drained and pus was obtained. His other signs and symptoms consisted of lassitude, fever, and splenomegaly. Tests showed: a Widal positive, one to 800; negative blood culture; and negative Wassermann. A roentgenogram of the femur showed a localized osteomyelitis. The patient was given prontosil without improvement. He was later given typhoid vaccine subcutaneously and intravenously, and made a recovery, the temperature coming down by lysis.—*Louis W. Breck, M.D., El Paso, Texas.*

FRACTURES OF THE ASTRAGALUS. Harold B. Boyd and Robert A. Knight. *Southern Medical Journal,* XXXV, 160, February 1942.

This is a report of fifty-eight cases of fracture of the astragalus treated by the staff of the Campbell Clinic in Memphis, Tennessee. The hazard of aseptic necrosis must be borne in mind in the treatment of these cases. Very accurate reduction is required in the treatment of these cases because of the many articular surfaces which must be accurately replaced. Open reduction is usually necessary, and internal fixation is often required to maintain the reduction. Subastragalar and astragalonavicular arthrodesis may be necessary. The fractures of the astragalus are classified, and appropriate treatment is described for each. Malunited or poorly reduced fractures require arthodesis of one or more joints. Astragalectomy is reserved for very severe cases or compound infected fractures.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

MADELUNG'S DEFORMITY (Case Report). J. Marsh Frere. *Southern Medical Journal* XXXV, 168, February 1942.

Only one case of Madelung's deformity was seen in more than 1200 fractures x-rayed at the Newell and Newell Clinic in Chattanooga, Tennessee. This deformity is due to idiopathic disturbances of the growth of the epiphysis of the lower radius, which cause deformity of the wrist, and apparent anterior subluxation of the hand. The

etiology is not known. Some think that trauma plays a part, others attribute it to endocrine disturbances. The ulna is not affected and as it continues to grow its lower end becomes prominent on the back of the wrist. The condition occurs four times more frequently in females than in males, and is usually first observed between the ages of ten and fourteen years. Heredity seems to play a part. Symptoms are pain, deformity, and limited motion of the wrist. Roentgenograms confirm the diagnosis. A typical case is reported with a review of the recent literature.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

TRANSPLANTS TO THE THUMB TO RESTORE FUNCTION OF OPPOSITION: END RESULTS. C. E. Irwin. *Southern Medical Journal*, XXXV, 257, March 1942.

Lack of opposition power in the thumb is a serious handicap to the usefulness of the hand. The grasping ability of the hand is decreased to the extent that its function is hardly more than a hook, and the finer movements of the hand are lost. The various movements of the thumb are discussed. Following an attack of infantile paralysis, many of these movements may be lost. A basic transplant to restore the usefulness of the thumb includes the following features:

1. The course of the transplanted tendon from the muscle belly to the pulley must be in a straight line.
2. The pulley must be so constructed that its original position will remain constant.
3. The pulley must be so constructed that it will allow free gliding movement of the tendon.
4. The tendon must lie in front of or toward the flexor side of the metacarpophalangeal joint as it passes to its insertion in the base of the proximal phalanx.
5. The tendon is fastened directly to the bone, entering the proximal phalanx of the thumb on the border adjacent to the web.

The details of the mechanical advantages of this transplant are described. The flexor sublimis tendon to the fourth finger is passed through a tendinous pulley, formed at the pisiform bone by a part of the flexor carpi ulnaris, is extended subcutaneously, and is attached to a tunnel in the second phalanx of the thumb. Contra-indications and postoperative treatment are discussed. The results obtained were good, twelve; fair, four; and poor, three.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

PALLIATIVE TREATMENT OF IRREDUCIBLE CONGENITAL DISLOCATIONS OF THE HIP. Charles J. Frankel. *Southern Medical Journal*, XXXV, 404, April 1942.

The methods used by various clinics in the treatment of this condition are: (1) shelving, (2) osteotomies, (3) anterior transposition, (4) no operative treatment, but the use of built-up shoes, and (5) a combination of these procedures.

It is reported that the results in 78 per cent. of the patients who had shelf operations were satisfactory.

The advantages claimed for osteotomy were: (1) safety and simplicity, (2) improved stability, (3) diminished lordosis, and (4) freedom from pain and fatigue.

One method, employed only in selected unilateral cases, has been used with some success to eliminate pain and fatigue. It consisted in preliminary traction to pull the head down, then arthrodesis by means of a bone graft driven into the neck and shaft of the femur at the distal end and into a trap door above in the ilium.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

THE NICOLA OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER. A REVIEW OF TWENTY-SIX CASES. R. Beverly Raney and Oscar L. Miller. *Southern Medical Journal*, XXXV, 529, May 1942.

This is a report on twenty-six cases in which the Nicola operation was performed on one shoulder. There were twenty-four males and two females. The average age

was twenty-one years. Eighteen cases were due to athletic injuries; three, to severe trauma; and five, to epileptic convulsions. The average period of time between the first dislocation and the operation was two years. Of this series of twenty-six operations, one or more redislocations after the operation developed in nine patients. Details of the cases of redislocation are given. But even these patients report very little discomfort or inconvenience, and are less disabled than before the operation. None of these patients has had a second operation. Some technical details to prevent recurrence of the dislocation are listed.—*Fred G. Hodgson, M.D., Atlanta, Georgia.*

A Critical Survey of Ten Years' Experience with Fractures of the Neck of the Femur. Mather Cleveland. *Surgery, Gynecology and Obstetrics*, LXXIV, 529, February 16, 1942.

The author analyzes the results obtained in the treatment of 110 fractures of the neck of the femur at St. Luke's Hospital from 1930 to 1940. The first fifty, already reported, are included for the sake of contrast.

Smith-Petersen's method of open reduction and internal fixation was used in fourteen cases, with very little improvement in end-results over those obtained by non-operative means. Of the seven patients whose fractures united, results in only two were wholly satisfactory. There were three cases of extensive aseptic necrosis, and two of severe malunion with marked deformity.

Undisplaced fractures of the neck of the femur, treated by three to four weeks' rest in bed and weight-bearing after the application of a Thomas caliper brace, gave invariably optimum results. A number of undisplaced fractures have been nailed without reduction.

Accurate closed reduction by manipulation and the careful insertion of a three-phlanged nail has yielded surprisingly good results; union of the fracture occurred in 86 per cent. of the survivors.

When circulatory disturbance occurred in the femoral head, it always appeared within the first year after the fracture. Seventy-five per cent. of the patients with non-union of the fractures had extensive circulatory disturbance in the femoral head. Of those subjected to open reduction, whose fractures had united, 42.8 per cent. showed extensive aseptic necrosis of the femoral head. Of the twenty-seven patients with united fractures, who had been treated by closed reduction and nailing, 18.5 per cent. showed some evidence of circulatory disturbance, for the most part very mild. The majority of all patients showing circulatory disturbance in the femoral head, whose fractures had united, had had an inadequate reduction of the fracture.

From experience with the last sixty patients, the author found that the most important single factor in securing union and avoiding circulatory disturbance in the femoral head was adequate reduction of the fracture. The actual or so-called migration of the nail is usually due to failure to properly reduce the fracture, and occurs almost exclusively in ununited fractures.

Tuberculosis of the Long Bones. The Importance of Its Differential Diagnosis from Pyogenic Osteomyelitis. Merrill Coleman Mensor. *The Western Journal of Surgery, Obstetrics and Gynecology*, L, 187, April 1942.

The author reports a case of multiple pyogenic osteomyelitis of the long bones in an adult, which proved to be of tuberculous origin. The similarity of this type of bone tuberculosis to that of the "common garden variety" of osteomyelitis and the importance of a differential diagnosis is stressed, as early diagnosis is essential for a good prognosis. It is a disease of adult life and not of childhood. Treatment should consist of saucerization and closure, followed by plaster-of-Paris immobilization,—particular care being taken to avoid secondary infection. The prognosis is always poor if metastases are present.—*F. Harold Downing, M.D., Fresno, California.*